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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 39599 and 40184.

38703 PROBLEMS OF NUCLEAR FUEL ANALYSIS. Neeb, K. H.; Gebauhr, W. (Siemens Aktiengesellschaft, Erlangen, Ger.). Fortschr. Chem. Forsch.; 12: 622-711(1969). (In German).

Topics covered include: analytical investigations on unirradiated fuel, determination of trace impurities, spectral analysis, neutron activation analysis of fuels for trace impurities, determination of small amounts of other actinides in Pu, determination of small oxygen contents in metallic and carbide fuels, determination of nitrogen, exact determination of actinides, determination of stoichiometry of UO_2 and of carbide fuels, composition of mixed oxides, isotopic composition of U and Pu in fuels, analysis of irradiated fuels, determination of fuel burnup, determination of conversion rates, and determinations of ^{239}Np, ^{233}Pa, ^{239}Pu, and ^{235}U. 257 references. (M.C.G.)

Chemical and Spectral Procedures

Refer also to abstracts 39333 and 39334.

38704 (BNWL-SA-2546) TOTAL BURN SPECTROGRAPHIC ANALYSIS OF PLUTONIUM OXIDE. Ko, Roy (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 28 Aug 1969. Contract AT(45-1)-1830. 8p. (CONF-690942-2). Dep. CFSTI.

From 13th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn.

Analysis of plutonium oxide by total burn spectrography is described. Determination of Si, Fe, Ta, Zr, Al, Cu, and other metals is reported. (M.C.G.)

38705 (DP-1215) CURIUM PROCESS DEVELOPMENT. III-6. CHARACTERIZATION OF EMULSIONS FORMED IN CURIUM SOLVENT EXTRACTION. Brown, D. A.; Marston, A. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr 1970. Contract AT(07-2)-1. 16p. Dep. CFSTI.

Qualitative analysis of emulsions that formed in the mixer-settlers in the curium separations process causing poor hydraulic performance showed silica, aluminum, and lithium as inorganic impurities, and amides as organic impurities. Solids that might contribute to emulsion formation in feed solutions were also analyzed. Impurities, such as dodecylamine in the extractant or sodium silicate in the aqueous phase, increased disengaging times in laboratory tests. Efforts to form and classify emulsions in the laboratory as stable as those in the curium process were unsuccessful. (auth)

38706 (DP-Report-253) GAS CHROMATOGRAPHY AND ITS APPLICATION TO GAS ANALYSIS FOR THE DETECTION OF TRACES. Project DRAGON. Lambert, Ch. (Societe L'Air Liquide, Brussels. Atomic Energy Establishment, Winfrith (England)). Jan 1964. 37p. Dep. CFSTI.

The principles, operation and performance of several models of the Lambert chromatograph are described. The apparatus has a sensitivity of 1 vpM in routine operation, for all the rare gases, hydrogen, oxygen, nitrogen, carbon monoxide, carbon dioxide, and hydrocarbons. By using an auxiliary technique the sensitivity can be extended to 1/100 vpM. (auth)

38707 (DP-Report-264) CHEMICAL ANALYSIS OF FUEL PARTICLES. Project DRAGON. Lingjaerde, R.; Podo, L. (Atomic Energy Establishment, Winfrith (England)). Apr 1964. 42p. Dep. CFSTI.

Selected chemical analytical techniques are described for the routine estimation of uranium, zirconium, thorium, and carbon in fuel particles, uncoated or coated with pyrocarbon or pyrocarbon/silicon carbide/pyrocarbon. The overall analytical error involved in analyzing these particles as well as other sources of error is discussed. (auth)

38708 (DP-Report-270) DEVELOPMENT OF PHYSICAL METHODS OF FUEL ANALYSIS. Annual Technical Report, February 1963-January 1964. Project DRAGON. Viehbock, F. P.; Paul, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). Apr 1964. 67p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, England.

Mass spectrometric methods for the determination of uranium isotopic ratios, uranium and thorium concentration in unirradiated and irradiated Dragon type fuel and separated fractions of such fuels are described. Also γ-spectrometric methods developed for the determination of the main fission products in undissolved samples of fuel, fuel fractions and graphite sleeves are reported. Methods for deconsolidating fuels into particles and graphite fractions are given. Results on Pluto 3A, Pluto 4A, HPD, and Studsvik fuel samples are included. A literature survey on the utilization of fission product isotope abundances for burn-up determination in mixed fuel is given. (auth)

38709 (DP-Report-423) AN EVALUATION OF CALIBRATION METHODS FOR DRAGON PROCESS GAS CHROMATOGRAPHS. Project DRAGON. Owens, D. R.; Salter, E. (Atomic Energy Establishment, Winfrith (England)). Apr 1966. 16p. Dep. CFSTI.

Calibration methods for gas chromatographs in the Dragon reactor system are discussed. These methods include static reduced pressure method and dynamic flow method. These methods were evaluated and their usefulness considered. (M.C.G.)

38710 (IS-T-385) CHROMATOGRAPHIC SEPARATION AND SPECTROPHOTOMETRIC DETERMINATION OF URANIUM. Itani, Salim Mohammed (Ames Lab., Iowa). May 1970. Contract W-7405-eng-82. 32p. Dep. CFSTI.

Thesis.

Uranium(VI) is quantitatively and qualitatively separated from the following ions. Cations: Li(I), Na(I), K(I), Mg(II), Ca(II), Sr(II), Bi(III), V(IV), Cr(III), Mn(II), Fe(III), Co(II), Ni(II), Cu(II), Zn(II), Zr(IV), Ag(I), Cd(II), Hg(II), Al(III), Pb(II), Ce(III), Dy(III), Yb(III), Th(IV); Anions: Cl^-, F^-, PO_4^{-3}, SO_4^{-2}, ClO_4^-, NO_3^-. The extraction of uranium(VI) is done by means of ion exchange column chromatography. The uranium is extracted by the Alamine 336 on Chromosorb W. Uranium(VI) stays on the stationary phase, while the other metal ions are stripped off by elution with 0.05 M sulfuric acid. The rare earth metals are co-extracted with uranium but are removed from the column by careful washing with 0.05 M H_2SO_4. Uranium is then complexed with Arsenazo I and is stripped off the column. The column is then washed with methyl alcohol (absolute), and the eluate is collected in a 50-ml volumetric flask. The concentration of uranium is determined spectrophotometrically. (auth)

38711 (KFK-1121) SIMULTANEOUS X-RAY SPECTROMETRIC DETERMINATION OF URANIUM AND PLUTONIUM IN SOLUTIONS OF IRRADIATED FAST BREEDER REACTOR FUELS. Ertel, D.; Wettstein, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Mar 1970. 34p. (In German). Dep. CFSTI (U. S. Sales Only).

Simultaneous x-ray spectrographic determinations of uranium and plutonium in aqueous and organic Purex Process solutions of irradiated fast breeder fuels were obtained by measuring the intensity of L_{α_1} lines; thorium serves as an internal standard. The measurements were made after placing 10 μl of the solutions of paper filters. The sensitivity of the method was about 3×10^5 imp/mg U and Pu. The standard deviation was about ±1%. (M.C.G.)

38712 (NBL-252) TITRIMETRIC DETERMINATION OF URANIUM IN PRODUCT, FUEL, AND SCRAP MATERIALS AFTER FERROUS ION REDUCTION IN PHOSPHORIC ACID. PART I. MANUAL TITRATION. PART II. AUTOMATIC TITRATION. Eberle, A. R.; Lerner, M. W.; Goldbeck, C. G.; Rodden, C. J. (New Brunswick Lab. (AEC), N. J.). Jul 1970. 40p. Dep. CFSTI.

The titrimetric method of determining uranium involving reduction to uranium(IV) by iron(II) in phosphoric acid, selective oxidation of the excess iron(II), and titration with dichromate has enormous potential to satisfy the burgeoning demand for faster and cheaper yet reliable uranium analyses required for the safeguard program. The method requires no prior separations even in the presence of iron, nitrate, plutonium, and other elements normally interfering with conventional redox methods. Significant improvements have been made that greatly increase the versatility and reliability of the method. The introduction of vanadium(IV) to the solution being titrated has dramatically sharpened the endpoint so that potentiometric titration can be used. Conditions have been found that permit large sample volumes to be analyzed. Studies of other parameters have been made. The proposed method can be used for virtually every step in the uranium fuel cycle. Analyses are reported of synthetic and actual sample solutions of product material, fuels of various types including mixtures of uranium with plutonium, zirconium, Zircaloy, thorium, stainless steel, aluminum, beryllium, and niobium, fuel scrap materials including dissolver solutions of many types, and residue samples. Dissolution procedures for a wide variety of solid samples are presented. Actual analysis time for typical sample solutions has been lowered from about 3 to 4 hr (2 days elapsed time) for conventional methods down to less than 15 min (1 hr elapsed time if an evaporation step is needed) for the recommended method. The accuracy and precision of results are also better, generally being well within 0.1%. The method is particularly attractive for automation because all operations are carried out in the same beaker and the reagent additions are generally not critical. Automatic titration was accomplished by the use of a timer-controller plus a basic commercial titrator that requires only simple modifications. Twelve samples can be analyzed within 3 hr with the proposed instrument. The reliability of the automatic titration appears to be only slightly less than that obtained with the manual titration. (auth)

38713 (PRNC-135, pp 451-67) APPLICATION OF NON-DISPERSIVE X-RAY SPECTROSCOPY TO THE ELEMENTAL ANALYSIS OF SELECTED CENTRAL AND SOUTH AMERICAN ORE SAMPLES. Mathiesen, J. M.; DaGragnano, V. L.; Hurley, J. P. (Naval Radiological Defense Lab., San Francisco, Calif.).

From Radiation and isotope technology in Latin American development.

Fluorescent x-ray measurements made on selected mineral and ore samples recovered from the areas of Central and South America as well as the United States are described. The technique makes use of energy dispersion with a high resolution solid state detector, rather than wavelength dispersion as provided by a diffraction crystal. The energy resolution of the detector enables the separation of adjacent elements down to Na, i.e., at a Z value of 11, to be made. The detector signals are amplified and recorded in a multichannel pulse height analyzer. The entire table of elements can be scanned simultaneously with this technique, an advantage when compared to the relatively slow scanning operation required by the diffraction method. The spectrometer system, shown schematically, was also designed for internal conversion electron-gamma coincidence studies, so that the geometry for x-ray fluoroscopy is far from ideal. The problems of geometry and suggestions for improvement are discussed. While a significant application of the method is as a sensitive qualitative elemental probe, the technique can also be used to obtain quantitative data under 10 ppM range. The corrections for matrix effects with the use of calibrated standards, similar to those made with diffraction spectroscopy, are discussed. The question of detector efficiency as a function of x-ray energy is also considered. (auth)

38714 DETERMINATION OF URANIUM AT THE MILLIGRAM LEVEL BY DICHROMATE AFTER REDUCTION BY TITANOUS CHLORIDE. de Miranda, C. F. (Institut de Physique Nucleaire, Arcueil, France). Radiochem. Radioanal. Lett.; 4: 113-18(8 Jul 1970). (In French).

An existing method for the volumetric determination of uranium (VI) at the 50 mg level was adapted to the milligram level with improved accuracy and precision. (auth)

38715 THE FLUORIMETRIC METHOD: ITS USE AND PRECISION FOR DETERMINATION OF URANIUM IN THE ASH OF PLANTS. Huffman, Claude Jr.; Riley, Leonard B. U. S., Geol. Surv., Prof. Pap.; 700-B: 181-3(1970).

The fluorimetric method for determining uranium in the ppM range in plant ash and a study of its precision are presented. The precision of results in the range from 0.4 to 35 ppM uranium in plant ash is expressed by a simple equation (standard deviation = 0.15 + 0.063 U, where U is the observed uranium concentration in ppM). This equation is based on 326 pairs of determinations, made during a period of about a year, on samples consisting of ash from sagebrush, piñon pine, ponderosa pine, and juniper. (auth)

38716 ANALYSIS OF THIN FILMS BY ION MICROPROBE MASS SPECTROMETRY. Evans, C. A. Jr.; Pemsler, J. P. (Kennecott Copper Corp., Lexington, Mass.). Anal. Chem.; 42: 1060-4(Aug 1970).

The ion microprobe mass spectrometer was used to investigate isotopic and compositional gradients in thin films of both oxides and metals. Continuous recording of intensities, and sputter rates as low as 0.5 Å/sec enabled depth resolutions of the order of 20 Å. Oxygen isotope mixing in duplex $Ta_2{}^{16}O_5/Ta_2{}^{18}O_5$ films was shown to vary with the $Ta_2{}^{18}O_5$ thickness added. Phosphorus gradients in Ta_2O_5 anodized in H_3PO_4 varied with film thickness and H_3PO_4 concentration. Homogeneities in thin films of Ag-Cu and Al-Ge-Nb depended on their modes of preparation. The ion microprobe is concluded to be a powerful tool for examining thin films. (auth)

38717 USE OF TOLUENE-3,4-DITHIOL FOR THE PHOTOMETRIC DETERMINATION OF MOLYBDENUM. Tanaka, Katu; Takagi, Nobuyuki (Industrial Research Inst., Kanazawa, Japan). Jap. Anal.; 19: 790-4(Jun 1970). (In Japanese).

Improvements in a method for photometric determination of Mo with dithiol were made, and the following procedure is recommended. Ascorbic acid (0.2 to 0.5 g) is added to a sample solution slightly acid with HCl, H_2SO_4, or $HClO_4$ to reduce Fe(III), Cr(VI), etc. Thiourea (0.5 g) and concentrated HCl (20 ml) are then added, and the solution is diluted to about 50 ml with water. After cooling, 2 ml of 1% zinc dithiol solution prepared freshly by dissolving the reagent in 1% NaOH solution are added. After 10 min the resulting Mo complex is extracted with 20 ml of CCl_4, and the absorbance is measured at 670 mμ against CCl_4. The following amounts of the elements are permissible without interference: Fe(III), 0.1 g; Bi, at least 10 mg; Te(VI), 10 mg; and 1 mg of each of the following elements: Cu(II), Ag, Hg(II), Sn(IV), As(III,V), Sb(III,V), Ge, Se (IV,VI), Te(IV), Au, Pt, and Pd. Up to 10 mg of W does not interfere in solutions 1.2 to 2.4 N in the presence of 10 g of citric acid. The method was successfully applied to the determination of Mo in steels and sulfide ores. (auth)

38718 ATOMIC FLUORESCENCE SPECTROMETRY OF ALUMINIUM, MOLYBDENUM, TITANIUM, VANADIUM, AND ZIRCONIUM IN INERT GAS SEPARATED NITROUS OXIDE-ACETYLENE FLAMES. Dagnall, R. M.; Kirkbright, G. F.; West, T. S.; Wood, R. (Imperial Coll. of Science and Tech., London). Anal. Chem.; 42: 1029-33(Aug 1970).

The atomic fluorescence characteristics of aluminum, molybdenum, titanium, vanadium, and zirconium in a nitrogen or argon separated nitrous oxide-acetylene flame were investigated using microwave excited electrodeless discharge tube sources. Atomic fluorescence was not obtained for titanium and zirconium, but the detection limits for aluminum and vanadium were ca. one order of magnitude better than those obtained by conventional atomic absorption spectrometry using the same basic instrument. The effects of 100-fold excesses of several diverse ions were studied for interference in both atomic fluorescence and atomic emission spectrometry. The atomic fluorescence signals were virtually free from interference for aluminum and vanadium, but the atomic emission intensity for each element suffered severe interference. (auth)

38719 INDIRECT DETERMINATION OF FLUORIDES BY THE EDTA TITRATION OF SAMARIUM. Combs, H. F.; Grove, E. L. (Illinois Inst. of Tech., Chicago). Talanta; 17: 599-606 (Jul 1970).

Fluorides were determined by the back-titration of excess of samarium with EDTA to the canary yellow end-point of Methylthymol

Blue. The fluoride was precipitated and digested in a solution buffered at pH 2.5 to 3.0 with monochloroacetate buffer. After digestion, the pH was adjusted to 5.6 to 5.8 with pyridine and the excess of samarium was back-titrated in the presence of the precipitate, for samples with small quantities of fluoride. The procedure was used to analyse simple fluorides, fluoroborates, and some other fluoro-complexes. (auth) (UK)

38720 SALINITY EFFECTS ON THE DETERMINATION OF STRONTIUM IN SEAWATER BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Carr, Roderick A. (Naval Research Lab., Washington, D. C.). Limnol. Oceanogr.; 15: 318-20(Mar 1970).

Salinity differences between samples and standards may be a source of error in the determination of Sr in seawater by atomic absorption spectrophotometry. If calibration is by reference to artificially prepared standards, these standards must match the sample solutions in salinity. For this reason, recently published values for Sr in the marine environment, determined by atomic absorption, are probably low. (auth)

38721 STUDY OF CERTAIN o,o'-DIHYDROXYAZO COMPOUNDS AS REAGENTS FOR ZIRCONIUM. Busev, A. I.; Cherkesov, A. I.; Zadumina, E. A. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 12: 1649-53(1969). (In Russian).

In a comparative study of a series of o,o' -dihydroxyazo compounds as reagents for zirconium, the effects of different substituents in the azo and diazo components on the composition, strength, and optical properties of the complexes formed were determined. Two of the compounds, picramicazo and picramicazo-H, can be used for the photometric determination of zirconium in acid media in the presence of significant quantities of Th^{4+}, UO_2^{2+}, and rare earths. (tr-auth)

38722 DETERMINATION OF VANADIUM IN REFRACTORY METALS, STEEL, CAST IRON, ALLOYS, AND SILICATES BY EXTRACTION OF AN NBPHA COMPLEX FROM A SULPHURIC-HYDROFLUORIC ACID MEDIUM. Donaldson, Elsie M. (Dept. of Energy, Mines, and Resources, Ottawa). Talanta; 17: 583-91 (Jul 1970).

A method for determining up to 0.15% of vanadium in high-purity niobium and tantalum metals, cast iron, steel, non-ferrous alloys, and silicates is described. The proposed method is based on the extraction of a red vanadium(V)-N-benzoyl-N-phenylhydroxylamine complex into chloroform from a sulphuric-hydrofluoric acid medium containing excess of ammonium persulphate as oxidant. The molar absorptivity of the complex is 428 l mole^{-1} mm^{-1} at 475 nm, the wavelength of maximum absorption. Interference from chromium(VI) and cerium (IV) is eliminated by reduction with iron (II). Common ions, including large amounts of titanium, zirconium, molybdenum and tungsten, do not interfere. (auth) (UK)

38723 SPECTROPHOTOMETRIC DETERMINATION OF A TRACE OF MOLYBDENUM IN TANTALUM WITH Zn-DITHIOL. Yamane, Takeshi; Iida, Keiki; Mukoyama, Tomoyuki; Fukasawa, Tsutomu (Yamanashi Univ., Takeda, Japan). Jap. Anal.; 19: 808-12(Jun 1970). (In Japanese).

A simple and rapid method was developed for determination of microgram or submicrogram quantities of Mo in Ta. After dissolution of the sample in HNO_3 and HF, Mo is extracted with carbon tetrachloride as Mo-dithiol complex from 2.5 N H_2SO_4 containing tartaric acid, and is determined spectrophotometrically by measuring the absorbance of organic phase at 680 mμ. The proposed method permits the determination of Mo as low as 0.1 ppM in Ta. The estimated standard deviations were about 0.03 to 0.005 ppM for the samples containing 0.7 to 0.3 ppM Mo and the time required for an analysis was about 90 min. The effects of the coexisting elements were also studied. (auth)

38724 COLORIMETRIC DETERMINATION OF BISMUTH WITH METHYLXYLENOL BLUE. Deguchi, Masakazu (Hiroshima Univ.); Okumura, Itsuo; Sakai, Kouji. Jap. Anal.; 19: 836-8(Jun 1970). (In Japanese).

A colorimetric determination of Bi was based on the red-violet complex with Methylxylenol Blue (MXB) in an aqueous solution. The complex had an absorption maximum at 575 mμ, and the absorbance was constant over the pH range from 1.2 to 1.3. Beer's law was obeyed over the range from 20 to 180 μg of Bi in 25 ml solution. The molar extinction coefficient was about 8900. The sample solution containing 20 to 180 μg Bi was mixed with suitable amounts of 0.2 N HNO_3 and 1.0 ml of 0.1% MXB, and the solution was diluted to 25 ml with water (the final pH 1.2 ~ 1.3). After 5 min, the absorbance was measured at 570 mμ against the reagent blank. Iron(III), Th(IV) and Mo(VI) interfered, but the permissible amount of Fe(III) was increased by addition of L-ascorbic acid. This method was simple and the results of recovery tests on synthetic samples (lead + bismuth) were satisfactory. (auth)

38725 EXTRACTION-PHOTOMETRIC DETERMINATION OF RARE-EARTH METALS WITH XYLENOL ORANGE IN THE PRESENCE OF DIPHENYLGUANIDINE. Imamverdieva, F. B.; Akhmedli, M. K. Uch. Zap. Azerb. Gos. Univ., Ser. Khim. Nauk; No. 2, 10-15(1968). (In Russian).

Complexes of the elements of the yttrium sub-group with Xylenol Orange (I), and I itself, are extracted into $CHCl_3$, CCl_4, or isobutyl alcohol (II) in the presence of diphenylguanidine (III); the distribution coefficient is 28%, the extent of extraction is 93%, and the optimum pH of the aqueous phase is 5 to 6. Extraction from 1 ml of 0.5mM rare earth metal requires 1 ml of 0.5mM-I, 8 ml of acetate buffer solution of pH 5.2, 10 ml of II, and 1.5 ml of N-III. On extraction there are bathochromic shifts of the absorption maxima of the complexes, and of I, as compared with the aqueous solution. A ternary complex is thought to be formed, containing the rare earth metal and I in the ratio 1 : 1. The extinction of the complex increases with increase in atomic weight of the rare earth metal and with decrease of its ionic radius. Under optimum conditions Beer's law is obeyed at 582 nm with 0.4 to 4 μg of Y, Dy, Ho, Er, Tm, Yb, and/or Lu per ml. There is no interference from the following (tolerable concentration as a ratio to the rare earth metal, given in parentheses)—Ga (1.4), Pb (7), Al (40), Ge (54), F^- (95), Fe^{III} (2), Th (87), and Ca (1500); or, with masking with F^-, Fe^{III} (7), Al (135), and Th (1160). Results are given for the determination of total rare earth metals in the presence of accompanying ions in prepared mixtures; the error is within ±1.34%. (Referativnyi Zh.)

38726 STUDIES ON THE ANALYTICAL CHEMISTRY OF HAFNIUM AND ZIRCONIUM. PART I. A REVIEW OF METHODS FOR THE DETERMINATION OF HAFNIUM AND ZIRCONIUM IN ADMIXTURE. Brookes, A.; Townshend, A. (Univ. of Birmingham, Eng.). Analyst; 95: 529-34(Jun 1970).

The available chemical and physical methods are discussed. The former are restricted to the determination of more than 0.1 per cent of hafnium in zirconium. Emission spectrography, x-ray fluorescence, and, especially, neutron activation analysis can be used for trace hafnium determination in zirconium. (auth) (UR)

38727 POLAROGRAPHIC DETERMINATION OF NIOBIUM IN ALLOY STEEL. Alvarez de Brito, J. M. (CENIM, Madrid). Rev. Met. (Madrid); 4: 633-5(1968). (In Spanish).

The sample (e.g., an alloy steel containing a high proportion of W or of Ni) containing 0.2 to 5% Nb is dissolved in HCl and oxidized with HNO_3, the solution is evaporated to dryness, and a solution of the residue in HCl is treated with a saturated solution of SO_2, diluted with H_2O, allowed to stand, then filtered. The precipitate is dried, heated to destroy organic matter, and calcined at 800°. The oxides obtained, which include those of Nb, Ta, Si, W, Ti, Zr, and Mo, are fused with KOH, the melt is extracted with dilute aqueous KOH, and the solution is acidified to pH ≈2 with dilute H_2SO_4 in the presence of EDTA. Any Mo present is extracted with a solution of 8-hydroxyquinoline in benzene. The aqueous layer is deaerated by passage of N and subjected to polarography from −0.4 to −0.9 V, and the height of the Nb wave ($E_{\frac{1}{4}}$ = −0.65 V vs the mercury-pool anode) is measured. (Anal. Abstr.)

38728 SPECTROPHOTOMETRIC DETERMINATION OF SMALL AMOUNT OF TELLURIUM IN IRON AND STEEL. Kawamura, Kazuo; Ito, Hideaki; Tanabe, Tomio (Fuji Iron and Steel Co., Ltd., Kanagawa, Japan). Jap. Anal.; 19: 824-9(Jun 1970). (In Japanese).

A spectrophotometric method for quantitative micro-analysis of Te in steel was established. Utilizing the difference in extractability of Te(VI) and Te(IV) with MIBK in hydrochloric acid solution, tellurium was separated from the other elements. The Te-Bismuthiol-II complex was then extracted into $CHCl_3$ after color-development with Bismuthiol-II. This complex was stable at least 24 hrs after color development, and its molar extinction coefficient at 330 mμ was 3.5×10^4. The analysis of steel samples by this method gave satisfactory results for as low as 5×10^{-4}% of Te. (auth)

38729 X-RAY ANALYSIS: ELEMENTAL TRACT ANALYSIS AT THE 10^{-12} g LEVEL. Johansson, T. B.; Akselsson, R.; Johansson, S. A. E. (Lund Inst. of Tech., Sweden). Nucl. Instrum. Methods; 84: 141-3(1970).

Using protons in the MeV region as excitation source and a high resolution Si(Li)-detector, x-ray analysis is capable of detecting many elements at the 10^{-12} g level simultaneously. (auth)

38730 DIFFERENTIAL PHOTOMETRIC METHOD FOR DETERMINING REFRACTORY MATERIALS. Korobka, L. A.; Tret'yak, Z. A.; Konik, L. P. Ogneupory; No. 5, 56-9(May 1970). (In Russian).

A differential spectrophotometric method was developed for determining the content of zirconium and hafnium dioxides in

refractory materials using the color reaction with Pyrocatechol Violet. The method determines zirconium content with an accuracy comparable to that of the complexometric method. (tr-auth)

38731 CATHODE REGION METHOD FOR THE SPECTROCHEMICAL (DC ARC) DETERMINATION OF IMPURITIES IN PLUTONIUM. Avni, R.; Boukobza, A.; Daniel, B. (Atomic Energy Commission, Beer-Sheva, Israel). Appl. Spectrosc.; 24: 406-10(Jul-Aug 1970).

A direct spectrochemical method for 47 impurities in plutonium was developed by exposing on the photographic plate only the cathode region instead of the whole arc gap. The dc plasma parameters were calculated for the two matrices, PuO_2 and U_3O_8. This method enables the measurement of similar parameter values for uranium and plutonium. The matrix factor was used for determination of impurities in PuO_2, with U_3O_8 as standard matrix for the analytical curves (log I/log C). The reproducibility of the method is within ±20% and the detection limits of the impurities are in the concentration range of a few parts per million. (auth)

38732 DIFFERENTSIAL'NYI SPEKTROFOTOMETRICHESKII ANALIZ. (Differential Spectrophotometric Analysis). Barkovskii, V. F.; Ganopol'skii, V. I. Moscow; Izdatel'stvo Khimiya (1969). 168p.

Methods of differential spectrophotometric analysis and various instruments and devices for differential photometric measurements are described in the first two chapters. The last chapter includes brief data on the methods of determination of elements and compounds including Al, Be, V, W, Fe, Co, Si, La, Mg, Mn, Cu, Mo, Ni, Nb, Na, H_2O_2, Pt, Pu, Re, Ta, Ti, U, P, F, and Zr. (R.V.J.)

38733 PHYSICAL TECHNIQUES OF CHEMICAL ANALYSIS. Wright, P. W. (Melbourne Research Labs.). Metals Aust.; 1: 379-81(Dec-Jan 1969-70).

Electron probe, mass spectroscopy, emission spectroscopy, atomic absorption, chemical and x-ray fluorescent methods of analysis are briefly compared with respect to mass sensitivity and range sensitivity. A summary graph compares the range for each technique in terms of mass sensitivity, atomic number and weight concentration. (Australia)

38734 CONCERNING APPLICATION OF SYNERGISM IN THE SUBSTOICHIOMETRIC ANALYSIS OF THORIUM. Remov, A. G.; Sobotovich, E. V. Radiokhimiya; 12: 182-3(1970). (In Russian).

Possibilities of the application of synergism for the substoichiometric analysis of microquantities of thorium are discussed. Its application in the determination of other elements is discussed. (tr-auth)

38735 DEVELOPMENT OF SUBSTOICHIOMETRIC METHOD FOR DETERMINATION OF MICROQUANTITIES OF THORIUM. Remov, A. G.; Sobotovich, E. V. Radiokhimiya; 12: 119-24(1970). (In Russian).

A substoichiometric method was developed for the determination of microquantities of thorium with an accuracy of ±2 to 3%. (tr-auth)

38736 PHYSICAL BASIS OF ATOMIC ABSORPTION SPECTROMETRY. II. INFLUENCE OF TEMPERATURE GRADIENTS ON SPATIAL DISTRIBUTION OF NEUTRAL ATOMS IN THE LONG PATHLENGTH CELL. Ando, Atsushi; Fuwa, Keiichiro; Vallee, Bert L. (Peter Bent Brigham Hospital, Boston). Anal. Chem.; 42: 818-25(Jul 1970).

The "long pathlength cell" has markedly lowered the detection limit for some elements in atomic absorption spectrometry, as predicted by Beers law. The detection of other elements, however, does not respond in a similar manner. To account for marked variations in the behavior of different elements, the concentration distributions of 21 elements were studied as a function of pathlength, using an air–hydrogen flame. Enhanced sensitivity of detection is shown to be a complex function of the pathlength, the nature of the flame, its shape and temperature, volatility of the elements, and their capacity for oxidation and reduction. The physicochemical basis of these observations and their pertinence to analysis by atomic absorption spectrometry are discussed. (auth)

38737 RAPID DETERMINATION OF SELENIUM AND TELLURIUM IN PRODUCTS OF THE METALLURGICAL TREATMENT OF ORES. Terzeman, L. N. Tr. Inst. Met. Obogashch., Akad. Nauk Kaz. SSR; 29: 56-60(1969). (In Russian).

A 0.2 to 2 g sample is heated with 20 ml of concentrated HNO_3; 20 ml of concentrated H_2SO_4 are added; the solution is evaporated to fumes; a little H_2O is added; and the solution is re-evaporated to fumes. Then 100 ml of H_2O are added to the residue, and the solution is heated to dissolve the salts. The residue is removed and washed with cold H_2O. The filtrate is made 10 vol % in HCl; 10 to 15 ml of 5% hydrazine sulfate solution is added; the solution is heated to 85°; 50% $SnCl_2$ in HCl (1:3) is added dropwise to decolorize the solution; and then 5 ml of $SnCl_2$ in excess is added. After 2 to 3 hr, the precipitated Se plus Te is collected on a paper-pulp pad, and the precipitate is washed with hot 5% HCl. The pad and precipitate are treated with 10 to 15 ml concentrated HCl plus 1 to 1.5 ml of concentrated HNO_3, and the paper pulp is then removed. Five g of urea are added to an aliquot of the filtrate (containing 5 to 20 mg of Se and Te); the solution is heated to 75 to 80°C; and then the solution is cooled. Then the TeO_3^{2-} is titrated with 0.02 to 0.5 N $KMnO_4$. Three g of KI are then added to the same solution, and after 2 to 3 min the liberated iodine (TeO_3^{2-} plus SeO_3^{2-}) is titrated with 0.1 N $Na_2S_2O_3$ in the presence of starch to a color change from violet to orange-red, the color of elementary Se. (Referativnyi Zh.)

38738 SIMULTANEOUS DETERMINATION OF CARBON, HYDROGEN, HALOGENS AND PALLADIUM, AND CARBON, HYDROGEN, AND PRASEODYMIUM. Bazalitskaya, V. S.; L'dokova, G. M. Izv. Akad. Nauk Kaz. SSR, Ser. Khim.; No. 6, 71-2(1968). (In Russian).

To determine the elementary composition of organic complexes and salts of Pd and Pr, 4 to 6 mg of a sample contained in a silica vessel are introduced into a silica combustion tube and pyrolyzed at 800 to 850°C in a stream of O for 30 to 40 min with Pd compounds or for 15 min with Pr compounds. The residue, PdO or Pr_6O_{11}, is cooled in a stream of O for 10 min, and is weighed 20 min after conclusion of pyrolysis. The contents of halogen, C, and H are found by the usual methods. The absolute error for each element is <0.5%. (Referativnyi Zh.)

38739 USE OF AMMONIUM FLUORIDE IN DETERMINATION OF ZIRCONIUM AND OTHER ELEMENTS BY ATOMIC ABSORPTION SPECTROMETRY IN THE NITROUS OXIDE–ACETYLENE FLAME. Bond, A. M. (Univ. of Melbourne, Parkville, Australia). Anal. Chem.; 42: 932-5(Jul 1970).

The use of NH_4F to improve the atomic absorption method for the determination of Zr in NO–acetylene flame was investigated in detail, and a concentration of 0.1 M NH_4F was found to enhance the Zr absorption by a factor of 8 to 10. The NH_4^+ and F^- enhancements are approximately equivalent and additive. The effects of NH_4F on the absorbance of a number of elements, along with the stability constants of the fluoride found in solution, the melting point of the likely oxides formed in the flames, and the melting points of some fluoride compounds are tabulated. Some theoretical explanations are offered for the enhancement mechanism. (B.L.M.)

38740 COMPUTER EXPERIENCE WITH VERY LOW-LEVEL GAMMA ANALYSES OF OCEANOGRAPHIC SPECIMENS. Grismore, R.; Weitz, W. E. Jr.; Folsom, T. R. (Univ. of California, San Diego). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 194-201(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The techniques used to radioassay for fallout nuclides (in particular, ^{137}Cs) by gamma spectrometry are described. Details are given of the computer analysis of the spectra, of the internal energy standardization by the 0.511-MeV annihilation and ^{40}K photopeaks, and of the use of smoothed background spectra. Agreement is shown between the computer method and a previously used freehand graphical method. (auth)

38741 ANALYSIS OF BINARY AND TERNARY THIN ALLOY FILMS OF TANTALUM, TITANIUM, NIOBIUM, ZIRCONIUM, MOLYBDENUM, AND BERYLLIUM. Sugawara, K. F.; Campbell, D. E. (Corning Glass Works, Corning, N. Y.). Microchem. J.; 15: 173-83(Jun 1970).

Accurate and rapid methods for the analysis of alloy films involving refractory-type metals are presented. The sensitivities of the methods are such that even smaller size samples can be adequately handled. If a film and substrate are subdivided into several sections and the ratio of the concentrations of the elements comprising the alloy is chemically determined to be uniform over the whole film, then one of the sections could logically serve as a standard for x-ray fluorescence analysis. The effect of niobium upon the pyrocatechol violet procedure for zirconium is reported. The data are summarized by a statistical treatment that indicates the relative standard deviation to be between 1 and 4% depending upon the method and the system. The 95% confidence limits are also estimated. (J.G.B.)

38742 POLAROGRAPHIC DETERMINATION OF URANIUM IN ORES AND MINERALS USING ASCORBIC ACID. Chung, Soon Ick (Korea Scientific and Tech. Information, Seoul); Park, Taek Kyu; Shin, Hyo Sun. J. Nucl. Sci. (Seoul); 9: No. 2, Pt. 1; 1-5(Apr 1970).

A rapid and accurate polarographic method is described for the determination of U in samples in the presence of over one thousand times this concentration of various other soluble elements, including Fe, Mn, Mg, Ca, and Al with lesser amounts of other soluble impurities and much silica. The materials analyzed include pitchblende, phosphate rock, carnotite, and monazite sand. In pitchblende, carnotite, and phosphate, the accuracy was within ±0.5%. Results were obtained more quickly by the use of a calibration curve when there were many samples to be analyzed. Ten samples can be analyzed in two days. (P.C.H.)

Isotopic Procedures

38743 IN VITRO RADIOISOTOPIC METHODS FOR THE DETERMINATION OF STEROID HORMONES. Maier-Hueser, H. (Centre d'Etudes Nucleaires de Saclay, Gef-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 147, 37-43(Apr 1970). (In French).

In vitro radioisotopic methods for the analysis of steroid hormones are reviewed. These methods include isotope dilution analysis by the double labeling technique, saturation or competition analysis with a binding protein, and radioimmunoassay. (58 references.) (France)

Radiometric Procedures

Refer also to abstracts 38776, 38777, 39194, 39196, 39197, 39220, 39379, 39412, and 39417.

38744 (CEA-R-3879) POSSIBILITIES OF GAS-PHASE RADIO-CHROMATOGRAPHY APPLICATION TO PERMANENT-GAS ANALYSIS. Dupuis, Marie-Claire; Charrier, Guy; Alba, Claude; Massimino, Daniel (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Jan 1970. 29p. (In French). Dep. CFSTI (U. S. Sales Only).

The gas-phase radio-chromatography technique was applied to the rapid analysis of permanent gases (H_2, O_2, N_2, Ar, Kr, Xe, Co, CH_4) labelled with radioactive indicators (^3H, ^{37}Ar, ^{85}Kr, ^{133}Xe). After calibration, the components of such a mixture can be identified and their concentrations measured in less than two hours, using a sample volume of from 0.1 to 10 cm^3. The minimum detectable activity is of the order of 10^{-4} μCi for each radioactive isotope. The measurements are reproducible to about 2 to 3 percent. The influence of parameters affecting the response of the radioactivity detector (ionization chamber or gas flow proportional counter) was considered. The method has very numerous applications both theoretically, for the study of chromatographic phenomena under ideal conditions (infinitesimal concentrations made possible by the use of radioactive tracers), and practically, for rapid and accurate radiochemical analysis of radioactive gas mixtures. (auth)

38745 (DP-Report-194) A NON-DESTRUCTIVE METHOD FOR THE DETERMINATION OF THE URANIUM AND THORIUM CONTENT OF POWDERS, COATED FUEL PARTICLES, AND FUEL CARTRIDGES. Project DRAGON. Barr, P.; Pointud, R. (Atomic Energy Establishment, Winfrith (England)). Oct 1963. (CONF-631115-1). Dep. CFSTI.

From Symposium on Post Irradiation Studies on Fuel, Harwell, Eng.

Radiometric measurements using the natural gamma activity of enriched uranium and thorium can be used for the quantitative determination of these two elements. The accuracy of this method for assaying coated particles or carbon powders can be better than 2% (calculated maximum relative error for a 99.7% level of confidence) by choosing the right sample holder and the appropriate number of counts. Samples of accurately known composition are required to establish the practical relative errors. Measurements on an accurately weighed thorium/carbon Dragon type fuel cartridge revealed a maximum theoretical relative error around ±5% and it was shown that an accuracy of ±1% could be obtained for compositions close to the standard. When uranium–zirconium and uranium–thorium cartridges of accurately known composition are made a determination of the practical accuracy can be obtained on this type of fuel. A theoretical maximum relative error around ±5% is predicted. (auth)

38746 (DP-Report-207(Pt.2)) RADIOCHEMICAL ANALYSIS OF FISSION PRODUCTS IN THE DRAGON REACTOR. PART II. EXPERIENCE OF FISSION PRODUCT ANALYSIS ON H.T.G.C. PLUTO LOOP AT HARWELL. Project DRAGON. Lengweiler, H. (Atomic Energy Establishment, Winfrith (England)). Aug 1963. 13p. Dep. CFSTI.

Experience gained from analysis of fission products during the operation of the Pluto Loop is surveyed. The fission product radiation is measured by two methods: periodic gas sampling in the coolant loop and scintillation counting using NaI crystals installed at different positions in the loop circuit. (M.C.G.)

38747 (DP-Report-260) PHYSICAL METHODS OF DETERMINING ISOTOPIC CONTENTS OF IRRADIATED FUEL SPECIMENS. Project DRAGON. Viehboeck, F. P.; Paul, H.; Bildstein, H. (Atomic Energy Establishment, Winfrith (England)). Mar 1964. 18p. Dep. CFSTI.

Mass spectrometric and gamma spectrometric methods for determining the isotopic composition of Dragon fuels are described. (auth)

38748 (DP-Report-301) DEVELOPMENT OF PHYSICAL METHODS OF FUEL ANALYSIS. Semiannual Technical Report, February–September 1964. Project DRAGON. Paul, H.; Viehbock, F. P. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physik-Institut). Nov 1964. Contract CON/WIN/52317/2. 52p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

For mass spectrometric determination of burnup and conversion of Dragon fuel, a special ion source and an apparatus for sample preparation from a single particle were developed. Axial and radial activity distributions in graphite from Pluto 5, Pluto 6, HPD 8, and HPD 9 were determined by computer analysis of gamma spectra measured in a standard geometry. (auth)

38749 (IA–1203) DETERMINATION OF RADIOELEMENTS AND TOXIC METALS IN URINE. MANUAL PART I. Padova, A. (ed.) (Israel Atomic Energy Commission, Tel Aviv). 1969. 30p. Dep. CFSTI (U. S. Sales Only).

A compilation of the analytical methods that are in current use in the Radiotoxicology section of the Radiation Safety Department is presented. Methods used for the determination of radioelements in urine include determination of gross alpha activity, gross beta activity, total beta activity, ^{45}Ca, ^{137}Cs, ^{60}Co, ^{32}P, ^{147}Pm, ^{35}S, T, U, Hg, and Pb. (D.H.M.)

38750 GAMMA–GAMMA SCATTERING METHOD FOR SIMULTANEOUS DETERMINATION OF TWO HEAVY ELEMENTS CONTENT IN ORES. Charbucinski, J. (Inst. of Nuclear Techniques, Krakow). Radiochem. Radioanal. Lett.; 4: 157-64(8 Jul 1970).

A nonspectrometric version of the γ-γ selective method for the determination of zinc–lead ores is presented. A possibility for extending the concept for ores containing two elements of high Z is discussed. (auth)

38751 RADIOMETRIC METHODS FOR THE DETERMINATION OF AMMONIA. Bowen, H. J. M. (Reading Univ., Eng.). Radiochem. Radioanal. Lett.; 4: 107-11(8 Jul 1970).

The amount of silver ion dissolved by passing solutions of ammonia through columns of silver chloride, iodate, and oxalate, each labeled with ^{110}Ag, was measured. It is concluded that silver (^{110}Ag) oxalate is the most suitable salt for rapid determinations of ammonia in amounts between 1 and 100 μmoles/ml (17 to 1700 ppM). (auth)

38752 SIMULTANEOUS DETECTION OF TRITIUM AND RADIOCARBON IN SOLID SCINTILLATION THIN-LAYER RADIOCHROMATOGRAPHY. Melo, T. B.; Prydz, Svein (Univ. of Oslo, Blindern, Norway). Anal. Chem.; 42: 1093-6(Aug 1970).

The detection of T and ^{14}C simultaneously but separately in thin-layer radiochromatography was investigated by measuring the light given off when β particles are adsorbed in solid scintillators added to the thin-layer media. (D.H.M.)

38753 APPLICATION OF ISOTOPICALLY-LABELED BROMINE FOR THE DETERMINATION OF TRACE UNSATURATION IN ALKANES. Gadeken, O. C.; Ayres, R. L.; Rack, E. P. (Univ. of Nebraska, Lincoln). Contract AT(11-1)-1617. Anal. Chem.; 42: 1105-8(Aug 1970).

A sensitive, simple procedure for analyzing trace quantities of unsaturation in hydrocarbon solvents by radiometric halogen addition is described. The direct addition of ^{82}Br-labeled Br_2 to the hydrocarbon was used. (D.H.M.)

38754 DETERMINATION OF COBALT USING ^{60}Co AND PAPER CHROMATOGRAPHY. Morse, Robert S.; Welford, George A. (Atomic Energy Commission, New York). Anal. Chem.; 42: 1100-2(Aug 1970).

A radioreagent technique for the determination of cobalt in steels was developed and applied to the assay of cobalt added to solutions of NBS steel standards. The technique is based on the equilibration of a constant amount of ^{60}Co with the cobalt in the dissolved steel sample. The cobalt is isolated by paper chromatography and the density of the tracer in the cobalt area on the paper is measured

by beta scintillation counting. These results are compared to those obtained by optical density measurements of radioautographs prepared from the chromatogram. (auth)

38755 RADIOACTIVE INERT GASES: TOOL FOR ANALYSIS OF GASES, LIQUIDS, AND SOLIDS. Anal. Chem.; 42: 16A-18; 20A; 22A-3; 25A-6; 28A; 30A-1(Aug 1970).

A review of the application of inert radioactive gases in the analysis of gases, solids, and liquids is given and related problems discussed. A radioisotopic method of analysis that retains all the precision and accuracy inherent in a volumetric titration while providing an objective end point has been developed by using kryptonates; the possibilities in the thermal analysis of solids have been improved with these techniques. (D.H.M.)

38756 DETECTION OF RADIOTUNGSTEN IN RAINWATER. Mamuro, Tetsuo; Matsunami, Tadao; Ishiyama, Toshio. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 1-4(1969).

Radioisotopes of tungsten ^{181}W, ^{185}W, and ^{188}W were detected in rainwater in Osaka in December 1968 and were assumed to have originated from the venting underground explosion carried out on December 8 by U.S.A. The nuclides ^{181}W and ^{188}W were detected by γ spectrometry with a Ge(Li) detector, while the presence of the nuclides ^{185}W and ^{188}W were confirmed by β spectrometry. The activity ratio of radioisotopes of tungsten, $^{181}W:^{185}W:^{188}W$, at the time of explosion was estimated to be about 1:1.6:0.5. (auth)

38757 DETERMINATION OF ACTINIDES IN BIOLOGICAL SAMPLES WITH BIDENTATE ORGANOPHOSPHORUS EXTRACTANT. Butler, F. E.; Hall, R. M. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Anal. Chem.; 42: 1073-6(Aug 1970).

A procedure for the determination of actinides was developed using the bidentate extractant dibutyl N,N-diethylcarbamylphosphonate. Nine actinides were extracted from 12N HNO_3, back-extracted to 2N HNO_3, and counted in a low-background alpha counter. A procedure was developed for sequential extraction of plutonium, neptunium, and uranium with tri-isooctylamine (TIOA), followed by extraction of thorium, americium, curium, berkelium, californium, and einsteinium with bidentate. Compared with previous methods the new procedure is simpler, requires less analysis time, and gives better recovery. The recovery of Am-Cm-Cf from 250 ml of urine or 20 grams of feces was 90%. Sensitivity of analysis is 0.02 ± 0.01 d/min/sample. An alternative method of exchange of trivalent actinides as oxalate anion complexes with TIOA is also described. (auth)

38758 APPROACH TO IMPLEMENTATION OF NONDESTRUCTIVE TESTING FOR ASSAY OF NUCLEAR FUELS. Jupiter, C. P. (Edgerton, Germeshausen and Grier, Inc., Goleta, Calif.). Int. J. Nondestruct. Test.; 2: 61-80(Jun 1970).

A number of the more important areas in the fuel cycle of a plant handling fissionable material are discussed, with respect to the present need for improving assay techniques to validate inventory records and ensure against diversion of the fuel to clandestine uses. A discussion of several active and passive nondestructive assay methods, which are now being developed or can be developed to provide adequate safeguarding in those areas, is also presented. Examples are given to illustrate that the present status of technology in many of the areas discussed is generally more than adequate to provide a basis to begin specific applications development and implementation in government and industrial fuel facilities. (auth)

38759 RADIOCHEMICAL METHODS FOR THE MEASUREMENT OF IN VITRO ENZYMATIC ACTIVITIES. Pichat, L. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Bull. Inform Sci. Tech. (Paris); No. 147, 49-54(Apr 1970). (In French).

Advantages and disadvantages of in vitro radiochemical methods for the determination of enzymes are reviewed. Some recent examples are tabulated. (41 references.) (France)

38760 RADIOCHEMICAL DETERMINATION OF SPECIFIC ACTIVITY OF ANTIMONY IN DIFFERENT OBJECTS. Maksimov, I. N.; Sysoeva, L. N.; Yakovleva, G. V. Radiokhimiya; 12: 189-91(1970). (In Russian).

The use of radiochemical methods for the determination of antimony in external media, such as rocks, clays, soils, vegetation, or water, is demonstrated. The chemical yields of Sb can be determined according to measurement of the γ-activity before and after radiochemical operations. The determination of specific radioactivity of Sb without dissolution of ground and clay samples requires 6 to 8 hours. The sensitivity of the radiochemical determination of the specific radioactivity of Sb is up to 10^{-10} Ci with the content of Sb in the limits of 0.1 γ and above. (tr-auth)

38761 RADIOISOTOPIC METHODS FOR THE DETERMINATION OF CATECHOLAMINES AND THEIR METABOLITES. Hardouin, J. C. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 147, 45-8 (Apr 1970). (In French).

In vitro radiochemical methods for the analysis of catecholamines are reviewed and compared to the fluorimetric methods. A double labeling technique is considered in detail. (J.B.B.)

38762 SURVEY OF OCEANIC FALLOUT TRACES USING CESIUM ABSORBERS. Folsom, T. R.; Grismore, R. (Scripps Inst. of Oceanography, La Jolla, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 202-10(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Large samples of fallout cesium can be collected for surveying oceanic distributions by absorbing upon certain types of ferrocyanide granules contacted with seawater. Sample size is conveniently normalized by reference to the natural nuclide also collected. Surveying and analytical techniques have been developed and much of the Pacific has been surveyed. (auth)

38763 INDICATION OF EQUIVALENCE POINT BY NEUTRON RADIATION (NEUTRON-ABSORPTION TITRATION). Dillinger, Pavel; Toelgyessy, Juraj (Solvenska Vysoka Skola Technicka, Bratislava). Chem. Listy; 64: 253-73(1970). (In Slovak).

The theory of the method of neutron-absorption titration, which uses the interaction of neutron radiation with the analyzed system to indicate the equivalence point is reviewed (13 references). An example of such an analysis is titration of 20 ml of 1 M KCl vs an $AgNO_3$ solution, with plotting of I_0/I vs ml of sample solution to determine the Ag. Two modifications of the technique are described, and diagrams of the equipment used, typical titration curves, and examples of tabulated data are presented. (TTT)

38764 INVESTIGATION OF RADIOACTIVITY IN INCINERATOR ASH. Brown, Roger C.; Peterson, Richard L. (Washington State Univ., Pullman). J. Occup. Med.; 12: 173-7(May 1970).

Three procedures were used to determine the radioactivity present in samples of incinerator ash at Washington State University. These procedures were gross beta-gamma activity determinations of ash samples in a proportional counter, gamma activity determinations by means of a 20 cm^3 Ge(Li) detector, and ^{90}Sr activity determinations by means of a radiochemical separation procedure. The gross beta-gamma activity determinations indicated monthly average specific activities from 6 to 94 pCi gm^{-1}. The gross gamma activity determinations identified 16 individual isotopes (^{155}Eu, ^{57}Co, ^{144}Ce, ^{226}Ra, ^{212}Pb, ^{233}Pa, ^{212}Bi, ^{214}Pb, ^{208}Tl, ^{214}Bi, ^{137}Cs, ^{54}Mn, ^{228}Ac, ^{65}Zn, ^{22}Na, and ^{40}K) in quantities from 10^{-3} to 10^{+1} pCi gm^{-1}. Radiochemical separations of ^{90}Sr were not too successful as only about 50% of the separations could be completed. The specific activity of ^{90}Sr in the successful separations ranged from 0.2 to 0.9 pCi gm^{-1}. (D.H.M.)

38765 DIFFERENTIAL ESTIMATION OF LOW ENERGY BETA-EMITTERS, ^{3}H, ^{14}C, AND ^{35}S IN MULTILABELED ORGANIC SAMPLES. Barakat, M. F.; Abdel-Ghany, Magda (Atomic Energy Establishment, Cairo). Microchem. J.; 15: 184-91(Jun 1970).

A simple technique is described for the determination of tritium, carbon-14, and sulfur-35 in multilabeled organic samples. Samples were ignited using different ignition systems and, through chemical discrimination between different radioactive oxidation products, the differential estimation of these low energy beta-emitters was achieved. Radioactivity measurement was carried out using the highly efficient and cheap gas flow monitoring counter. Results obtained showed clearly that the described technique also could be successfully applied, with great accuracy and good reproducibility, for the individual determination of any of the above-mentioned isotopes in multilabeled samples. (auth)

Activation Procedures

Refer also to abstracts 39141, 39253, 39329, and 40577.

38766 (IA-1204) SHUTTLE: A FORTRAN PROGRAM FOR ACTIVATION ANALYSIS USING VERY SHORT-LIVED NUCLIDES. Wiernik, M. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). Dec 1969. 37p. Dep. CFSTI (U. S. Sales Only).

A FORTRAN program to facilitate handling the large amount of data obtained from repeated measurements using very short-lived nuclides (half-life ≈ 1 sec) is described. (auth)

38767 (IFA-MR-33) MEASUREMENT OF THE CONTAMINATION OF RADIOGENIC ARGON WITH ATMOSPHERIC ARGON BY SCINTILLATION SPECTROMETRY. Danis, A.; Iorgulescu, A.

(Institutul de Fizica Atomica, Bucharest (Romania)). 1970. 6p. Dep. CFSTI (U. S. Sales Only).

The possibility of the air contamination measurement by neutron activation analysis using scintillation spectrometry was investigated. Preparation of the counter vial and the shape of ^{37}Ar spectrum are shown. (auth)

38768 (IFA-NR-31) QUANTITATIVE DETERMINATION OF IMPURITIES IN NUCLEAR GRAPHITES BY INSTRUMENTAL ACTIVATION ANALYSIS. Cojocaru, V.; Filby, Royston (Institutul de Fizica Atomica, Bucharest (Romania)). 1970. 10p. Dep. CFSTI (U. S. Sales Only).

The use of a good resolution Ge(Li) detector makes it possible to determine the concentration of more than 20 elements in nuclear graphites by aid of instrumental activation analysis. It was shown that standard rocks can be successfully used for concentration determination, making the method simpler than the use of standard solutions. The errors are usually around 10% and sometimes larger due to the errors of the concentrations in standard rocks. Nevertheless, they are the same order of magnitude or less than the non-homogeneity of the trace elements in measured graphites. The sensitivity depends on the isotope and can go up to $10^{-10}-10^{-11}$ for many elements. (auth)

38769 (IS-T-360) INSTRUMENTAL ACTIVATION ANALYSIS OF RARE EARTH MIXTURES. Becknell, Duane Ernest (Ames Lab., Iowa). May 1970. Contract W-7405-eng-82. 112p. Dep. CFSTI.

Thesis.

A nondestructive instrumental activation analysis method was developed for the determination of the composition of heavy (Sm–Lu) rare earth mixtures. The method employs two irradiations of the same set of samples, the first being in epithermal neutrons for the analysis of all rare earths except Dy which is subsequently analyzed by thermal neutron reirradiation. Data collection could be completed in as little as 48 hours from the time of the initial irradiation. The reduction of these data increase the total time required to complete the analysis to 60 hours. Unlike many methods currently being used, the procedure developed requires no preirradiation wet chemistry or postirradiation separation of the elements. It was applied to mixtures of one-to-one composition with the exception of Eu which was present at one-tenth the amount of the other rare earths. In addition, samples of a simulation of gadolinite, a heavy rare earth ore, were analyzed. The results were within ±4 percent of the actual values in the poorest case while errors of ±2 percent were more common. Studies of the self-shielding effects due to Sm, Gd, and Eu showed that in the concentration ranges studied the effect due to Eu was negligible in both epithermal (V-3) and thermal (R-5) irradiations as was the effect due to Gd in V-3. In R-5 both Gd and Sm exhibited self-shielding effects as did Sm in V-3. Since Gd was analyzed in a V-3 irradiation its self-shielding in R-5 did not interfere with the analysis. In the case of Sm in both R-5 and V-3 self-shielding became important only when the Sm content exceeded 2.5 mg. Samples of "unknown" composition were also studied using the gadolinite simulation as a standard. These "unknowns" were analyzed with accuracies of ±2 percent being common but ranging up to ±4 percent. (auth)

38770 (PRNC-135, pp 93-7) UTILIZATION OF THE IAN-R1-10 KW REACTOR. Arroyo A, Alfredo (Instituto de Asuntos Nucleares, Bogota (Colombia)). (In Spanish).

From Radiation and isotope technology in Latin American development.

General aspects of the uses of the reactor at the Instituto de Asuntos Nucleares are described. The professionals who use it may be catalogued into three different fields: activation analysis with neutrons; radioisotope production; and research in pure chemistry. Activation analyses include those in the field of metallurgy (such as alloys of Au, Pt, and Pd, which are used in dental applications), agriculture (wheat, barley, and corn seeds to determine their K, Cl, and Mn content and their relation to other soil research), and petroleum (including determination of vanadium in petroleum from different parts of the country). Radioisotope production includes that of gold-198 (for cancer irradiation), phosphorous-32 (for agricultural research), and radioisotope generators (such as $^{99}Mo/^{99m}Tc$, $^{90}Sr/^{90}Y$, and $^{132}Te/^{132}I$. Research in pure chemistry includes isotope interchange to know the type of linkings of some elements in organic molecules, and isomeric pair yield. (auth)

38771 (PRNC-135, pp 167-82) ACTIVATION ANALYSIS BY 16-MeV ELECTRON LINAC. Azuma, Toshio (Radiation Center of Osaka Prefecture, Osaka (Japan)).

From Radiation and isotope technology in Latin American development.

The bremsstrahlung from the 16-MeV electron linac with 30 micro-amperes has been used to activate elements and compounds commercially available. The gamma spectra were observed by 3 × 3 in. NaI flat type and 2 × 2 in. well type, and no chemical separations were used. The activated Monazite(Malay) and uranium ore(Ningyo-stone, Japan) show the thorium and uranium spectra in spite of the presence of other elements. Ten elements were estimated in activated human blood. Poly (vinyl chloride) (PVC) sheets and rubber vulcanizates were specially made to contain known amounts of several metal contents, which were estimated by gamma spectra. (auth)

38772 (PRNC-135, pp 183-6) CHARACTERIZATION OF STANDARD REFERENCE MATERIALS FOR INDUSTRY AND RESEARCH BY NEUTRON GENERATOR ACTIVATION ANALYSIS. Nargolwalla, S. S.; LaFleur, P. D. (National Bureau of Standards, Washington, D. C.).

From Radiation and isotope technology in Latin American development.

Examples that demonstrate the use of a low-cost neutron generator facility for materials characterization in the steel and oil industries are described. Analytical results for oxygen in steels and for the metallic component in a number of organometallic oil additives are given. The accuracy of these results is indicated by the close agreement of the activation data with that obtained by conventional and well proven chemical methods. These applications illustrate the utilization of standard materials useful for industrial and research needs. (auth)

38773 (PRNC-135, pp 189-94) FUNCTION OF EXCITATION FOR THE REACTIONS OF $^{181}Ta(d,p)^{182}Ta$, ^{103}Rh, $(d,2p)^{105}Ru$, AND $^{197}Au(d,p)^{198}Au$. Nassiff, Sonia F. J. (Buenos Aires Univ. (Argentina). Comision Nacional de Energia Atomica, Buenos Aires (Argentina)); de Betancourt, I. (Instituto de Asuntos Nucleares, Bogota (Colombia)). (In Spanish).

From Radiation and isotope technology in Latin American development.

The cross sections for excitation functions for the above mentioned nuclear reactions were determined experimentally as part of an Activation Analysis with Charged Particles program. The energy of the deuterons in the incidental beam was 27.5 MeV. The stacked foil process was used to reduce the energy to the corresponding threshold amount. The flow of the incidental beam was determined by the activity of ^{24}Na resulting from the reaction of ^{27}Al (d,p) ^{24}Na. The excitation functions were determined by absolute measurement of the activities of the reaction products. The intensities of the gamma rays were measured with a 2 by 2 in. NaI(Tl) crystal and a multichannel pulse-height analyzer. The results were compared with calculated values based on a model, which supposes a direct reaction mechanism. (auth)

38774 (PRNC-135, pp 195-200) INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS FOR ALUMINUM IN PHOSPHATE MINERALS. Galli, Ann N.; Smith, Dorsey; McLain, Milton E. Jr. (Georgia Inst. of Tech., Atlanta).

From Radiation and isotope technology in Latin American development.

The determination of the aluminum content of phosphate minerals by conventional chemical techniques such as colorimetry is often complicated by the presence of fluorine in the natural mineral. Acting as a strong complexing agent for the aluminum, the fluorine requires the analyst to go to extremes to remove this interfering element prior to the aluminum color development. Not only is this time consuming (and therefore expensive), but leaves doubt as to the validity of the resulting aluminum analysis data. Standard phosphate samples from the National Bureau of Standards and samples of phosphate minerals mined in the southeastern United States have been analyzed using the Georgia Tech. Research Reactor. The development of the procedure has shown that these determinations can be performed at a rate of several hundred per day. The accuracy and precision of the method have been evaluated. Competing methods, such as atomic absorption, have been used and the results compared from a standpoint of cost of analysis as well as the resulting accuracy and precision. (auth)

38775 (PRNC-135, pp 201-12) RAPID NEUTRON ACTIVATION ANALYSIS IN FOOD AND DRUG APPLICATIONS. Lambert, Joseph P. F.; Simpson, Robert E. (Food and Drug Administration, Washington, D. C.).

From Radiation and isotope technology in Latin American development.

Rapid analyses were possible for vanadium, selenium, and several elements found in drugs. Chemical techniques were employed to satisfy sensitivity requirements, to remove interferences associated with other elements found in the sample matrix, and to permit a rapid analysis of a complicated matrix.

NAA analysis without chemical separations usually resulted in a rapid determination of a few elements with several additional elements being identified by monitoring a sample over a longer period of time. The selection and use of detectors were based on the needs of the analysis. The elements and the radioactive characteristics used in their detection are tabulated. These analyses have shown the effectiveness and versatility of neutron activation analysis in applied research and in regulatory operations. (auth)

38776 (PRNC-135, pp 421) DETERMINATION OF ARSENIC IN GERMANIUM BY ASSOCIATION OF ISOTOPIC DILUTION AND ACTIVATION ANALYSIS. Lima, Fausto W.; Silva, Celia M. (Instituto de Energia Atomica, Sao Paulo (Brazil)).

From Radiation and isotope technology in Latin American development.

Activation analysis of arsenic in a germanium matrix may suffer interference caused by arsenic isotopes formed in the irradiation of the germanium matrix itself. Isotopic dilution will avoid such interference but will require weighing very small masses of arsenic. This procedure can be avoided if the mass of the recovered arsenic is determined by activation analysis. Arsenic labeled with ^{76}As is added to the germanium sample. The sample is dissolved in aqua-regia, evaporated almost to dryness, the residue is taken with water, the solution is made alkaline with ammonium hydroxide, and a lead nitrate solution is added. The lead hydroxide precipitate formed will carry the arsenic. ^{76}As activity in the lead hydroxide precipitate is determined and compared with that of the added ^{76}As to determine the recovering yield for arsenic. The lead hydroxide is irradiated in a thermal neutron flux of about 10^{13} n/sec.cm^2, together with standards of As_2O_3, for eight hours. The irradiated lead hydroxide and As_2O_3 standards are processed to separate arsenic, whose activity is determined as before. In this way the value of the specific activity B in the isotopic dilution formula $x = a(A/B - 1)$ can be calculated. a and A are the amount and specific activity, respectively, of labeled arsenic; x is the amount of arsenic in the germanium sample. (auth)

38777 (PRNC-135, pp 422-6) DETERMINATION OF IMPURITIES IN PURE REAGENTS BY ASSOCIATION OF ISOTOPIC DILUTION AND ACTIVATION ANALYSIS. APPLICATION TO THE ANALYSIS OF COPPER IN VARIOUS REAGENTS. Atalla, Laura T.; Lima, Fausto W. (Instituto de Energia Atomica, Sao Paulo (Brazil)).

From Radiation and isotope technology in Latin American development.

The problem of reagent impurities is important in analytical chemistry since many products such as semiconductor materials, ultrahigh-purity metals, samples to be used as standards, and others, must be analyzed for impurities at ultratrace level, i.e., concentrations corresponding to less than 1 ppM. In such analysis the reagent impurity may be the principal source of contamination of the sample to be analyzed. Activation analysis would be the method par excellence for such materials. However, direct irradiation of some chemicals is, sometimes, an unpleasant matter. Such is the case for irradiation of corrosive chemicals (HCl, HNO_3, NH_4OH), owing to radiolysis phenomena and build-up of gaseous pressures within irradiation containers. The isotopic dilution method applied to such samples would avoid direct irradiation of samples. Determination of masses in the recovered material obtained after chemical processing, in the classical isotopic dilution procedure, can be made by activation analysis instead of gravimetric methods. The techniques involved in the determination of Cu in HNO_3, HCl, NH_4OH, and $(NH_4)_2S$ are described. (auth)

38778 (PRNC-135, pp 432-9) ASSOCIATION OF THE METHODS OF ACTIVATION ANALYSIS AND ISOTOPIC DILUTION: DETERMINATION OF COPPER IN HIGH PURITY GOLD SAMPLES. Lima, Fausto W.; Atalla, Laura T. (Instituto de Energia Atomica, Sao Paulo (Brazil)).

From Radiation and isotope technology in Latin American development.

Activation analysis of impurities in high neutron cross section matrices is complicated by problems such as neutron flux depression and very high activity levels induced in the matrix, making difficult the handling and processing of the sample. Application of the isotope dilution method to such a sample would avoid the handling of high activities and neutron shadowing problems. However, isotopic dilution makes the weighing of very small masses necessary to determine specific activity of the substance to be analyzed, after chemical separation. Weighing such small masses is not often easy; activation analysis, instead of gravimetry, may, in some cases, improve results. The method and results are described. (auth)

38779 DETERMINATION OF MICROAMOUNT OF OXYGEN IN ZONE-REFINED IRON BY THE 14-MeV NEUTRON ACTIVATION METHOD. Furuya, Keiichi; Koizumi, Makoto; Kikuchi, Tadashi (Tokyo Univ.). Jap. Anal.; 19: 7875-80(Jun 1970). (In Japanese).

To determine oxygen at the 1-ppM level in zone-refined iron by the 14-MeV neutron activation method, an electropolished sample was irradiated in a nitrogen atmosphere by means of a newly designed target glove box for eliminating high back ground and recoiled ^{16}N contamination, which amounts as high as 5 ppM for sample weight of 8.5 g. Oxygen contents by the activation method under a controlled time schedule were in good agreement with those by the vacuum fusion method. (auth)

38780 MERCURY PIGMENTATION, AN ELECTRON MICROSCOPIC STUDY. Burge, Kelmar M.; Winkelmann, Richard K. (Univ. of Minnesota, Rochester). Arch. Dermatol.; 102: 51-61 (Jul 1970).

The ultrastructure of tissue pigmented through prolonged use of mercury-containing cosmetic creams was studied. Mercury was identified in the tissue by the technique of neutron-activation analysis. Metallic granules were observed electron microscopically in dermal macrophages, in association with elastic fibers, and lying free in the dermis. Melanin pigmentation increased secondary to the presence of the heavy metal. Vacuolated dendritic cells were observed at the dermoepidermal junction. (auth)

38781 DETERMINATION OF OXYGEN IN COPPER BY ^3He ACTIVATION ANALYSIS. Lee, Diana M.; Stauffacher, Cynthia V.; Markowitz, Samuel S. (Univ. of California, Berkeley). Anal. Chem.; 42: 994-8(Aug 1970).

A radioactivation method using ^3He as the bombarding particle was developed to determine trace concentrations of oxygen in copper. The limits of detection extend to about 0.35 ppB with a sensitivity of approximately 29 dpm/ppB of radioactive 110-min ^{18}F which is used as the signal for ^{16}O. The ^{18}F is produced by by the nuclear reaction of ^{16}O with low-energy (4 to 10 MeV) ^3He ions. The 0.51-MeV annihilation radiation from the ^{18}F is detected by a NaI scintillation spectrometer, or by a Ge gamma-ray spectrometer. At ^3He energies below 6.3 MeV, no interfering radioactivities from reactions with the Cu matrix are present so the analysis is nondestructive. If necessary, destructive analysis may be carried out and a rapid, clean procedure for radio-chemical separation of ^{18}F as PbF_2 is presented. The method is calibrated either absolutely through measurement of beam intensity, detection coefficient, cross section, and bombardment time, or through a comparative method based upon standards of known oxygen content prepared by anodic oxidation of tantalum foils. The oxygen content of 0.1-mil Cu foil was measured to be 550 ± 30 ppM (0.055 ± 0.003%). The relative standard deviation was 5%. Only fractions of a milligram of sample are required. The possibility of continuous analysis using low-energy "desk-top" cyclotrons designed specifically for ^3He ions is suggested. (auth)

38782 COMPUTER-BASED SYSTEM FOR NEUTRON ACTIVATION ANALYSIS. Tunnicliff, D. D.; Bowers, R. C.; Wyld, G. E. A. (Shell Development Co., Emeryville, Calif.). Anal. Chem.; 42: 1048-55(Aug 1970).

The system of activation analysis described is intended for routine application to the wide variety of samples encountered in an industrial research laboratory. The computer program determines the qualitative and quantitative composition of the sample which gives the best least-squares fit to the spectral data for up to 6 different decay times. The instrumentation includes a special nonlinear energy scale which provides the maximum amount of information in the minimum number of channels and records the spectral data directly on computer compatible magnetic tape. A method of computing the reference spectra of the individual radionuclides from data for a mixture of a radionuclides is included. (auth)

38783 COMPARATIVE DETERMINATION OF SILICON IN LYMPH NODES BY NEUTRON ACTIVATION AND SPECTROPHOTOMETRY. Miskovits, G.; Orban, E.; Dubay, M.; Appel, J.; Oerdoegh, M.; Szabo, E. (Univ. Medical School, Budapest. Central Research Inst. for Physics, Budapest). Acta Morphol. Acad. Sci. Hung.; 18: No. 1, 73-8(1970).

The amount of silicon in biological material was determined by neutron activation and spectrophotometry. The advantages of the procedure are discussed. The amount of silicon in the silicotic lymph nodes was three times as high as in normal lymph nodes. It is suggested that determination of silicon by means of neutron activation may facilitate the diagnosis of silicosis. (auth)

38784 ROUTINE PROCEDURE FOR THE DETERMINATION OF STRONTIUM AND BARIUM IN ROCKS AND SEDIMENTS BY NEUTRON ACTIVATION ANALYSIS. Das, H. A.; Hoede, D.; Macke, J. F.; Zonderhuis, J. (Reactor Centrum Nederland,

Petten, Netherlands). Radiochem. Radioanal. Lett.; 4: 171-80 (8 Jul 1970).

The concentrations of barium and strontium in silicate samples are often lower than 1000 ppM. The quantitative separation of these two elements from the other constituents is a time-consuming procedure. The separation of barium and strontium is difficult. For routine analyses it is of great value to have a method that does not involve either of these two difficult steps. Neutron activation analysis offers this possibility. The method presented is based on a short irradiation of the sample in a high thermal neutron flux. After fusion with carbonate, the melt is dissolved in nitric acid. The main interfering elements are then eliminated by hydroxide precipitation. The residual manganese is extracted with quinolinol. Strontium and barium are precipitated as carbonates and the γ spectrum of the precipitate is recorded. The chemical yield (20 to 50%) is determined by reactivation after decay of the original radioactivity. (auth)

38785 ACTIVATION ANALYSIS OF AIRBORNE DUST. Mamuro, Tetsuo; Fujita, Akira; Matsuda, Yatsuka. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 9-20(1969).

A preliminary experiment was made before beginning a long-term observation of air contamination by neutron activation and some required basic data were obtained. Airborne dust was collected for four weeks on a membrane filter and the dust sample was irradiated by neutrons together with several references. Gamma spectrometry of the activated samples was made with a large volume Ge(Li) detector. Atmospheric concentrations of several elements were determined without chemical separation procedures. It was also confirmed that atmospheric concentrations of many other elements can be determined easily if proper references are prepared. (auth)

38786 ACTIVATION ANALYSIS OF RIVER-WATER. Mamuro, Tetsuo; Fujita, Akira; Matsuda, Yatsuka; Matsunami, Tadao; Yoshida, Toshio; Oka, Takashi. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 21-3(1969).

A preliminary activation analysis experiment was made on water sample from a river into which some waste water discharged from a tungsten mine pours. X-ray fluorescence spectroscopy confirmed presence of eleven metallic elements. Twenty elements were detected by activation analysis, and it was confirmed that the concentrations of the detected elements were determinable if proper references were prepared. Some future plans for monitoring the river water are described. (auth)

38787 (γ,γ') AND (γ,n) ACTIVATION. Azuma, Toshio; Sato, Yuji; Miki, Ryota; Kondo, Yoshihide. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 29-30(1969).

The sensitivities of (γ, γ') activation were measured for the elements of Ba, Cd, Hg, Sn, Sr, In, and Lu, at the Linac energy of 6 MeV with beam current of 70 μA. The test activation was tried to remove the effects of ^{34m}Cl by using the differences of (γ,n) activation threshold energies for Au, In, Sc, Cl and Ti, at the Linac energies of 11 to 16 MeV, 30 μA. (auth)

38788 NONDESTRUCTIVE ANALYSIS USING SHORT LIVING NUCLIDES I. 20 ms 71 m Ge. Bradstaedter, O.; Girsig, F.; Grass, F.; Flenk, R.; Bauer, R. (Oesterreichische Hochschule, Vienna. Univ., Vienna). Atomkernenergie; 15: 285-7(1970). (In German).

Initially a brief description is given of an automatic pneumatic tube system with only 15 ms or transfer time, which renders possible neutron activation analysis in this half-life range. Quantitative results were obtained both from the decay curves and the corresponding gamma spectra. The technique was demonstrated for the analysis of Ge traces in iron meteorites. The nondestructively obtained results were compared with results from activation analysis followed by chemical separation of Ge. The data were in excellent agreement. The sensitivity limit was determined at 100 μg Ge for the stationary operation and 5 μg Ge for the pulse operation. The results obtained were limited by the electronic detection system. (auth)

38789 NEUTRON-ACTIVATION DETERMINATION OF TRACE IMPURITIES IN GERMANIUM OF SPECIAL PURITY. Razumova, G. N.; Shuba, I. D.; Vasil'ev, I. Ya. Radiokhimiya; 12: 133-7(1970). (In Russian).

A neutron activation method was used with ion-exchange chromatography for the determination of trace impurities in germanium. Microgram quantities of Cu, Au, Sb, As, Hg, Zn, Cd, and Fe were determined. (tr.-auth)

38790 NONDESTRUCTIVE NEUTRON ACTIVATION ANALYSIS OF AIR POLLUTION PARTICULATES. Dams, R.; Robbins, J. A.; Rahn, K. A.; Winchester, J. W. (Univ. of Michigan, Ann Arbor). Anal. Chem.; 42: 861-7(Jul 1970).

A nondestructive and computer assisted neutron activation analytical procedure for the determination of up to 33 elements in air pollution particulates was designed and tested in studies of samples taken in and near the Northwest Indiana industrial area. Samples are counted after (1) 3 min, (2) 15 min, (3) 20 to 30 hours, and (4) 20 to 30 days following neutron irradiation for (1) Ca, Ti, V, Cu, Al, S, (2) Na, Mg, Mn, In, Cl, Br, I, (3) K, La, Sm, Eu, Cu, Zn, W, Au, Ga, As, Sb, Br, (4) Sc, Ce, Th, Cr, Fe, Co, Ni, Ag, Zn, Hg, Sb, Se using a Ge(Li) detector. (auth)

38791 NEUTRON DETERMINATION OF INDIUM AND CADMIUM IN A FLOWING SOLUTION. Kartashev, E. R.; Shtan, A. S. Tr., Vses. Nauch.-Issled. Inst. Radiats. Tekh.; No. 3, 200-6(1969). (In Russian).

Automatic apparatus was developed for the simultaneous continuous determination of In (2 to 30 mg/l) and Cd (5 to 20 g/l) in flowing industrial tailings solution from the hydrometallurgical extraction of In and Cd. The Cd is determined by the absorption of thermal neutrons, and In is determined by neutron activation, with recording of the induced γ-activity due to ^{116m}In (half-life 59.2 min) or measurement of the β-activity of ^{116}In (half-life 13 sec). A correction for change in the Cd concentration must be made in the results for In. The source of neutrons is Pu–Be yielding $\approx 5 \times 10^6$ n/sec. The mean relative error of the determination of Cd is ±5%. (Referativnyi Zh.)

38792 NONDESTRUCTIVE DETERMINATION OF FLUORINE BY PHOTON ACTIVATION USING A BETATRON. Kosta, Lado; Slunecko, Jaroslav (Univ. of Ljubljana, Yugoslavia. Inst. Jozef Stefan, Ljubljana, Yugoslavia). Anal. Chem.; 42: 831-5(Jul 1970).

The reliability and the versatility of the photon activation method were demonstrated by determining F in concentrations between 0.01 and 5% in a variety of materials, such as organic and inorganic fluorine containing pharmaceuticals, fluorapatite, and vanadium concentrate, using amounts of sample from 0.1 to 1.0 gram. Interferences from the elements, such as Cl, Bn, As, Sn, Ag, Cr, or Zn can be eliminated or reduced to minimum by adjusting irradiation time, waiting period, and the energy of the primary electron beam. Results by activation are in good agreement with those obtained by the distillation-titration method, and give a precision better than 2%. (auth)

38793 NUCLEAR ACTIVATION ANALYSIS FOR ULTRA-SENSITIVE DETERMINATIONS OF ENVIRONMENTAL POLLUTANTS. Pretorius, Rene (Southern Universities Nuclear Inst., Faure, South Africa); Wainerdi, Richard E. S. Afr. Med. J.; 44: 169-71(14 Feb 1970).

Nuclear activation analysis is one of the most sensitive analytical methods presently available for the determination of the majority of the elements, and as such it can contribute significantly to environmental pollutant studies. The principles of the method are described, and the nondestructive nature of the technique is emphasized. The specificity and sensitivity, adaptation to automation, and use in tracer studies are discussed. Several applications to the determination of air and water pollutants, pesticides, and rare element concentrations in human tissues are cited. (auth)

38794 ACTIVATION ANALYSIS OF METALS FOR OXYGEN BY USING NEUTRON GENERATORS WITH SEALED TUBES. Nikolaenko, K.; Shtan, A. S. Tr., Vses. Nauch.-Issled. Inst. Radiat. Tekh.; No. 3, 193-200(1969). (In Russian).

Use was made of the nuclear reaction ^{16}O(n,p)^{16}N with fast neutrons of 14 MeV energy obtained in a neutron generator with a sealed tube. The apparatus comprises the neutron generator in a concrete shield, a pneumatic device for rapid conveyance of sample and standard from the irradiation position to the measurement position and back, and a γ detection system of three single-channel scintillation γ spectrometers with NaI(Tl) crystals (8 cm × 8 cm). The sample and standard, in the form of discs of 4-cm diameter and 1-cm thickness (powdered samples are placed in capsules of aluminum or titanium), are irradiated for 12 sec in a neutron flux of $\approx 5 \times 10^5$ n/cm^2 sec, 1 sec after irradiation the activity of the ^{16}N formed (half-life 7.35 sec) is measured for 12 sec from the radiation of energy >3 MeV (with aluminum capsules the level of discrimination is increased to 4.5 MeV). To improve the sensitivity and accuracy, the cycle of irradiation and activity measurement is repeated several times. The method can be used to determine from ≈0.1% of O in copper or titanium with an error of 10% or 15%, respectively. (Referativnyi Zh.)

38795 NONDESTRUCTIVE DETERMINATION OF PLATINUM METALS IN ORES, MATTE, AND LEAD ASSAY BEADS BY REACTOR ACTIVATION ANALYSIS AND HIGH RESOLUTION GAMMA SPECTROMETRY. Turkstra, Jacob; Pretorius, P. J.; de Wet, W. J. (National Nuclear Research Centre, Pretoria). Anal. Chem.; 42: 835-41(Jul 1970).

Instrumental reactor activation analysis using a Ge(Li) detector was investigated for the nondestructive determination of the noble

metals in lead beads, matte, and platinum-bearing ores. This technique proved feasible and appears very promising for the analysis of small lead beads and matte samples, but unfortunately Pd cannot be determined in the presence of abundant Cu in matte samples and necessitates chemical separation. Ni and Cu can, however, in addition be determined in matte. Au, Pt, Ir, Cu, and Ni can be determined in platinum-bearing ores, but the precision is poor due to excess activities from other abundant matrix elements present. (auth)

38796 DETERMINATION OF CARBON IN HIGH PURITY METALS BY PHOTON ACTIVATION ANALYSIS. Lutz, G. J.; Masters, L. W. (National Bureau of Standards, Washington, D. C.). Anal. Chem.; 42: 948-50(Jul 1970).

A reliable method was developed for the determination of C in high-purity metals at levels of 1 ppM or less. The method is based on the photon activation of the C according to the reaction $^{12}C(\gamma,n)$ ^{11}C and a post-irradiation chemical separation. The method was used to determine C in Au, Ag, Zn, Cd, and Mo. (B.L.M.)

38797 CURRENT AND POTENTIAL APPLICATIONS OF RADIOISOTOPE X-RAY AND NEUTRON TECHNIQUES OF ANALYSIS IN THE MINERAL INDUSTRY. Watt, J. S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Australas. Inst. Mining Met. Proc.; No. 233, 69-77 (Mar 1970).

Radioisotope x-ray and neutron techniques of analysis can be used for the determination of a wide range of elements in minerals. The most important applications of these techniques to the mineral industry are for on-stream analysis of slurries and solids, and for geological assay. The radioisotope x-ray techniques are the more developed ones and two installations for on-stream analysis are in routine use in mineral processing plants in Australia. Neutron techniques are being developed, and should prove valuable for geological assay of large numbers of mineral samples, for borehole logging, and for specific on-stream analysis when the cost of the equipment is warranted. (auth)

38798 NEUTRON ACTIVATION ANALYSIS OF POTSHERDS FROM KNOSSOS AND MYCENAE. Harbottle, G. (Brookhaven National Lab., Upton, N. Y.). Archaeometry; 12: 23-34(Feb 1970).

Twenty sherds of each of two groups, representing pottery finds at Mycenae and Knossos, were analyzed by neutron activation for ten elements (Co, Cr, Eu, Fe, Sc, Nl, Cs, Ta, Th, and Hf). The results indicate that this procedure can be a useful complement to the emission spectrographic method of analysis, both as a check on the latter and as a means of extending the range of elements determinable to considerably lower concentrations. One sample in each of the two groups definitely seemed not to belong to its supposed compositional category: with these exceptions, the groups established by emission spectrographic analysis appeared to retain their homogeneity when elements present at a lower concentration level were determined. (auth) (UK)

38799 EQUIPMENT FOR THE DETECTION OF RESIDUAL FUEL IN LEACHED HULLS BY NEUTRONS COUNTING. Jover, P. (CEN, Saclay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 517-19(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Equipment has been developed for detecting small amount of fissile materials remaining in hulls, after irradiated fuel dissolving operation. The equipment described is running in French fuel processing plant AT-1 located at La Hague (France). The method consists of first, leached-hulls irradiation by neutron generator, and secondly, delayed-neutron counting techniques. It makes possible the monitoring of one basketful of leached-hull pieces in 30 minutes and the detection of an amount of 20 milligrams uranium-235 equivalent with 100% accuracy. (auth)

38800 RADIOACTIVATION ANALYSIS STUDIES OF POLYMERIZATION REACTIONS, I. SOLUTION POLYMERIZATION OF STYRENE BY RADICAL CATALYSIS. Maekawa, T. (Kyoto Univ.); Matsuo, M.; Yoshida, H.; Hayashi, K.; Okamura, S. Polymer; 11: 342-50(Jul 1970).

Radioactivation analysis was used to detect trace amounts of solvent fragments attached to polymer chain ends in a study of the mechanism of chain transfer to solvent in the polymerization of styrene in chloroform, methylene dichloride, ethylene dichloride, and bromobenzene. The polymerization was carried out at 60°C with α, α'-azobisisobutylonitrile as initiator. It was confirmed that the fragments of solvent molecule, even with bromobenzene as solvent, became attached to the polymer during the course of the transfer reaction. This is in accordance with the generally accepted mechanisms of the transfer reaction. (auth) (UK)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 38770, 38913, 38917, 38983, 38985, 39027, 39028, 39033, 39220, 39390, 39621, 39678, 39679, 39683, 39684, 39692, 39704, 39713, and 40181.

38801 (AEC-tr-6875) RARE-EARTH ELEMENTS AND THEIR POSITION IN THE PERIODIC SYSTEM. Trifonov, D. N. Translation of Redkozemel'nye Elementy i ikh Mesto v Periodicheskoi Sisteme, Izdatel'stvo, Nauka, Moscow, 1966. 240p. (TT-67-59069). Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 3077.

38802 (DP-Report-108) OXIDATION OF GRAPHITE WITH OXYGEN BETWEEN 1000°C AND 2000°C. Project DRAGON. Nagle, J. F. M. (Atomic Energy Establishment, Winfrith (England)). Aug 1962. 22p. (CONF-620305-4; CONF-620407-3). Dep. CFSTI.

From Carbon Transfer Discussion Meeting, Dorchester, Dorset, England and Meeting of the Royal Institute of Engineers Nuclear Energy Section, The Hague, Netherlands.

The rates of oxidation of carbon and graphites were measured in the temperature range 1000 to 2000°C at pressures of 0.06 to 1 atmosphere with gas velocities varying from 100 to 10,000 cm/sec. Cold gas was directed on to the side of an electrically heated carbon rod; its temperature was measured by a disappearing filament pyrometer. By timing the retreat of the surface of the rod opposite the jet orifice, the rate of reaction was calculated. At atmospheric pressure and high temperatures the combustion rate of the most reactive material, the porous carbon, was found to be mass transfer controlled and the mass transfer rates were correlated against gas velocity, the carbon temperature, the oxygen partial pressure and the total gas pressure. When a less reactive reactor graphite was oxidized at lower total gas pressure the rate was only partly controlled by mass transfer in the gas phase and by using the previously mentioned correlations the influence of mass transfer on the combustion rate was estimated. The least reactive material, pyrographite, seemed to be free from mass transfer control, so the combustion rate was in the chemical regime. Both the reactor graphite and pyrographite reaction rates reached a maximum at about 1700°C and then decreased at higher temperatures. This effect has been found before by Strickland-Constable with a maximum rate at 1200°C. The oxygen pressure used in this work was about 0.2 atmospheres. Explanations of the rather unusual kinetic behavior of graphite were proposed. (auth)

38803 (DP-Report-117) CONTRIBUTION TO THE STUDY OF CARBON OXIDATION. Project DRAGON. Lang, F. M. (Atomic Energy Establishment, Winfrith (England)). Nov 1962. 22p. (CONF-620305-1). Dep. CFSTI.

From Carbon Transfer Discussion Meeting, Dorchester, Dorset, England.

In chemically controlled kinetics the phenomenon of carbon oxidation is intimately related to its developed surface. For dry gases, either air or CO_2, and well purified carbon the specific rate is, for each gas, and for well determined pressure and temperature conditions, a constant, independent of the carbon origin; the presence of water and probably hydrogen may be important. (auth)

38804 (DP-Report-276) THE EFFECT OF MOISTURE ON THE ADSORPTION OF KRYPTON ON CHARCOAL. Project DRAGON. Roemberg, E. (Atomic Energy Establishment, Winfrith (England)). May 1964. 14p. Dep. CFSTI.

The presence of moisture was found to reduce the krypton adsorption coefficient proportional to the water vapor pressure up to 40% relative humidity. A simple theoretical treatment based on Raoult's Law represents the results well and allows extrapolations to other krypton/moisture concentrations. (auth)

38805 (NP-9983) PROBLEMS ASSOCIATED WITH THE PENETRATION OF NOBLE GASES THROUGH GRAPHITE. Project DRAGON. Schmidt, H. (Atomic Energy Establishment, Winfrith (England)). Jan 1961. 14p. (DP-Report-12). Dep. CFSTI.

In the Dragon Reactor Experiment graphite will be used for the containment of fission products for two different items, the fuel box and the fuel rod. Requirements for the quality of the graphite for both parts are different. They are working under different conditions and their performance leads to different consequences. The fuel boxes contain the fuel pellets and together with the fuel rod form a purge gas annulus which is continuously ventilated.

The noble gases which are created inside the fuel box will after a certain delay, which depends on different parameters, enter the purge gas and will be largely transported to the fission product plant. This means that the quality of the fuel box is responsible for the heat load in the clean up plant. The fuel element rod has to separate the relatively highly contaminated purge gas from the main coolant circuit and is therefore the critical item for the activity, at least the noble gas activity, in the main cooling circuit and finally for the leak tightness specification of the reactor vessel. Naturally the quality of the fuel boxes has an influence as well, but normally the limiting factor is the long lived fission products which are leaving the fuel boxes at the same rate at which they are created. (auth)

38806 (SC-T-70-4031) CONCERNING THE DIRECT H-T AND H-D EXCHANGE REACTION IN ALKYL AROMATICS, UTILIZING HYDROGENATION CATALYSTS (EXCERPTS ONLY). Baumeister, M. Translated by Marcel I. Weinreich (Sandia Labs., Albuquerque, N. Mex.), from pp 4-7 of Ueber die Direkte H-T und H-D Austauschreaktion an Alkylaromaten unter Verwendung von Hydrierungskatalysatoren, Munich, W. Ger. 4p. Dep. CFSTI.

Activity measurements were made by liquid scintillation spectrometry and radio gas chromatography. The dependence of amount of incorporated tritium on the quantity of utilized catalyst and on the overall supply of tritium was determined. Deuterium distribution in the compounds was measured mass spectrometrically. (M.C.G.)

38807 (Y-1724) PITCH, POLYFURFURYL ALCOHOL RESIN, AND STYRENE-DIVINYLBENZENE COPOLYMERS AS CARBON BINDERS. Schmitt, C. R. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant), 20 Jul 1970. Contract W-7405-eng-26. 42p. Dep. CFSTI.

Analytical data were obtained on the carbon, hydrogen, sulfur, nitrogen, oxygen, and ash content of various commercial vegetable, petroleum, and coal-tar pitches. The pitches were also characterized by gel permeation chromatography, thermogravimetry, and molecular weight studies. Carbon compact formulation and density studies were made using a polyfurfuryl alcohol resin binder. The compacts were made by pressing isostatically at 30,000 psi and coking at 950 and 1,500°C under a flowing helium atmosphere. Preparation of styrene-divinylbenzene copolymers was studied by heating a mixture of the monomers of styrene and divinylbenzene in corked test tubes suspended in a mineral oil bath at a controlled temperature. The effect of temperature on the polymerization of caustic-washed monomers was determined. Extent of the oxidation of uranium dicarbide by the pyrolysis of the styrene-divinylbenzene copolymer and solidified polyfurfuryl alcohol resin was also compared. Coking-yield studies on various styrene-divinylbenzene copolymers showed that the coking yield was proportional to the divinylbenzene content, and that the highest coking yields were obtained using one weight percent p-toluenesulfonic acid as a catalyst. (auth)

38808 KINETICS OF IODINE EXCHANGE BETWEEN MONOIODOACETIC ACID AND MOLECULAR IODINE IN BENZENE. Koroes, E.; Orban, M.; Burger, M. (Eoetvoes Univ., Budapest). Radiochem. Radioanal. Lett.; 4: 165-9(8 Jul 1970).

^{131}I exchange between molecular iodine and monoiodoacetic acid (IAcOH) in benzene was studied. The rate equation describing the exchange is the following: $v = k_0(IAcOH)$. The activation parameters are: E = 13.9 kcal/mole, lg A = 6.14, $\Delta S^{\neq} = -31$ e.u. (auth)

38809 ASSOCIATION AND SOLVATION OF ISOTOPIC DIMETHYLAMINE IN n-HEXANE. Wolff, H.; Wuertz, R. (Univ., Heidelberg). Z. Phys. Chem. (Frankfurt); 69: 67-80(Apr 1970). (In German).

The association constants, association energies, heats of evaporation, solvation energies, and excess functions are calculated from the activity coefficients for solutions of the isotopic dimethylamines $(CH_3)_2NH$, $(CH_3)_2ND$, $(CD_3)_2NH$, and $(CD_3)_2ND$ in n-hexane. Insofar as the accuracy permits a judgement, an increase was found in the corresponding values in those cases in which associated amino groups are deuterated. However, a reduction was observed for the deuteration of the monomeric amino groups and the deuteration of the groups not involved in association. The increase and the decrease are explained from the differences of the inter- and the intramolecular vibrations under the assumption of a nonclassical behavior of the intermolecular vibrations of associates, but of an approximately classical behavior of the intermolecular vibrations of monomers. This interpretation is analogous to that of the normal vapor pressure isotope effects of associates and to that of the inverse effects of monomers. (auth)

38810 PREPARATION AND PRELIMINARY STRUCTURE INVESTIGATION OF β-TETRAKIS(ACETYLACETONATO)-NEPTUNIUM(IV). Titze, H.; Allard, B. (Univ. of Goteborg). Acta Chem. Scand.; 24: 715(1970).

Light green needle-shaped crystals with melting point 175 ± 2°C were prepared. The lattice parameters from Guinier photographs indicate by comparison with previously examined acetylacetonates of tetravalent metals that the B-form was obtained. (Denmark)

38811 THERMAL REACTION OF THE U(VI) AND Th(IV) 8-HYDROXYQUINOLINE ADDUCTS. Corsini, A.; Abraham, J. (McMaster Univ., Hamilton, Ont.). Can. J. Chem.; 47: 1435-7(15 Apr 1969).

The use of [^{14}C]-8-hydroxyquinoline has shown that when the 8-hydroxyquinoline adducts, $UO_2(C_9H_6NO)_2 \cdot C_9H_7NO$ and $Th(C_9H_6NO)_4 \cdot C_9H_7NO$, are thermally converted to the normal compounds, $UO_2(C_9H_6NO)_2$ and $Th(C_9H_6NO)_4$, intermolecular ligand exchange in the solid phase occurs. The extent to which the exchange equilibrium proceeds suggests that the thermal energy absorbed is sufficient to promote considerable metal-ligand bond rupture. (auth) (Canada)

38812 SOLUBILITY SYSTEMS WITH ZINC AND RARE EARTH METAL NITRATES. Brunisholz, G.; Klipfel, L. (Institut de Chimie Minerale et Analytique, Lausanne, Switzerland). Rev. Chim. Miner.; 7: 349-58(1970). (In French).

In order to determine the existence range of the double salts $2[Ln(NO_3)_3] \cdot 3[Zn(NO_3)_2] \cdot 24H_2O$ (Ln = rare earth metal) the four ternary systems $Ln^{3+}-Zn^{2+}-NO_3^-H_2O$, with Ln = La, Pr, Nd, and Sm, were investigated. In the first three systems, the double salt has a congruent solubility with a very large existence range at 20°C. The samarium compound has an incongruent solubility at temperatures below 36°C; its existence range is very narrow at 0°C, and considerably increases with increasing temperature. The 20°C solubility isotherms of the quasi-ternary systems corresponding to the pairs La-Pr, La-Nd, and Pr-Nd, with formation of the mixed crystals $2[(Ln, Ln') (NO_3)_3] \cdot 3[Zn(NO_3)_2] \cdot 24H_2O$ were also established; the three systems belong to Roozeboom's type I (continuous series of mixed crystals with neither a maximum nor a minimum in solubility). (France)

38813 SELECTIVITY IN THE REACTIONS OF ETHYLENE AND DEUTERIUM ON TUNGSTEN: EFFECT OF TEMPERATURE. Rye, Robert (Cornell Univ., Ithaca, N. Y.). J. Res. Inst. Catal., Hokkaido Univ.; 17: 223-7(Dec 1969).

Some published literature reporting the hydrogenation of ethylene on W is discussed. The reactions of ethylene with D at various temperatures are discussed in the light of the published findings. Below 200°K, where dehydrogenation of adsorbed ethylene on the catalyst has a negligibly slow rate, W was found to be a relatively good hydrogenation catalyst. Above 200°K, the main reaction shifts from hydrogenation to olefin exchange; and above 300°K, complete dehydrogenation to a C residue was reported. 10 references are cited. (B.L.M.)

38814 STABILITY OF U(VI)-CHELATES OF SOME N-SUBSTITUTED SALICYLHYDROXAMIC ACIDS. Ghosh, Nripendra Nath; Mukherjee, Aruna (University Coll. of Science, Calcutta). Sci. Cult. (Calcutta); 35: 697(Dec 1969).

Stability constants K_1 and K_2 are presented for U(VI) chelates of salicylohydroxamic acid (RH_1), N-methylsalicylohydroxamic acid (RH_2), and N-phenylsalicylohydroxamic acid (RH_3). Results show the stability of U(VI) chelates is in the ligand order $RH_1 > RH_2 > RH_3$ and in accordance with the steric effect. During titration the bis-chelate of RH_1 was precipitated. But in the cases of RH_2 and RH_3 no precipitation took place and there were indications of the formation of polynuclear complexes at higher pH. (D.H.M.)

38815 KHIMIYA DOLGOZHIVUSHCHIKH OSKOLOCHNYKH ELEMENTOV. (Chemistry of Long-Lived Fission Elements). Sinitsyn, N. M.; Korpusov, G. V.; Zaitsev, L. M.; Levin, V. I.; Sinitsyna, S. M.; Prokopchuk, Yu. Z.; Zaitsev, B. A.; Grivkova, A. I.; Voloshenko, L. L. Moscow; Atomizdat (1970). 327p.

The state of chemistry of the main long-lived radioactive elements formed in the fission of nuclear fuel was studied. The technology of purification of nuclear fuel from fission elements and the complex treatment of wastes from radiochemical processes were examined. Special attention was devoted to the chemical characteristics of compounds of fission elements formed on regeneration of nuclear fuel and on separation of isotopes. The radiochemical properties of these elements, the main classes of their compounds, their stereochemistry and valence state, their behavior in solution, and methods of selective isolation of these elements were studied. The specific fission products considered are: Cs, Sr, rare earths, Zr, Nb, Ru, and Tc. (tr-auth)

38816 PHASE DIAGRAMS OF THE SYSTEMS $ThCl_4$-UCl_3 AND $PuCl_3$-UCl_3. Desyatnik, V. N.; Nichkov, I. F.; Porodnov,

P. T.; Raspopin, S. P.; Skiba, O. V. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 101-3(1970). (In Russian).

The phase diagrams of the binary systems $ThCl_4-UCl_3$ and $PuCl_3-UCl_3$ were studied. It is shown that there is a compound in the $ThCl_4-UCl_3$ system, $3UCl_3 \cdot ThCl_4$, which is unstable above 750°C and which forms a eutectic mixture with $ThCl_4$. In the system $PuCl_3-UCl_3$, the compound $3UCl_3 \cdot PuCl_3$, unstable above 700°C, was identified; it forms a eutectic mixture with $PuCl_3$. (tr-auth)

38817 CHLORINATION OF THORIUM DIOXIDE. Ketov, A. N.; Mal'tsev, N. A.; Shligerskii, A. S. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 94-100(1970). (In Russian).

On the chlorination of ThO_2 by chlorine in the presence of carbon, by phosgene, and by carbon tetrachloride, the oxychloride or the tetrachloride of thorium are formed, depending on the temperature. In the case in which mixtures of chlorine and carbon oxides are used, the product of the reaction is thorium oxychloride only. The chlorinating reagents in order of their decreasing chlorinating capability for formation of $ThOCl_2$ are: $COCl_2-CCl_4-(Cl_2+C)-(Cl_2+CO)$, and for formation of $ThCl_4$ are: $COCl_2-(Cl_2+C)-CCl_4$. The high reaction capability of phosgene is explained by formation on thermal decomposition of phosgene not only of atomic chlorine but also of excited molecules of CO or COCl radicals. (tr-auth)

38818 MODEL CALCULATIONS OF HYDROGEN ISOTOPE EFFECTS FOR NON-LINEAR TRANSITION STATES. O'Ferrall, R. A. More (Rice Univ., Houston, Tex.). J. Chem. Soc., B; No. 5, 785-90(1970).

Calculations are reported showing that primary hydrogen isotope effects depend smoothly on transition state geometry and yield consistently low values, $k_H/k_D = 1-2$, for sufficiently non-linear configurations. Specific calculations for 1,2-hydride shifts, borane hydrolyses, and E2C eliminations were compared with available measurements for these and for other hydrogen transfer reactions proceeding through 3-, 4-, 5-, and 6-membered cyclic transition states. A unique temperature-independent k_H/k_D is noted. The low isotope effects are ascribed to the presence of a large isotopically sensitive vibration $\nu_R^{\ddagger}$ (e.g., 3500 cm^{-1}) in the transition state. The results are fairly insensitive to reasonable force-constant changes. The usefulness of k_H/k_D in defining the geometry of transition states for hydride transfer reactions is discussed. (auth) (UK)

38819 ISOTOPIC EXCHANGE OF ARENE CHROMIUM TRICARBONYLS IN AN ACID MEDIUM. Kursanov, D. N.; Setkina, V. N.; Baranetskaya, N. K.; Zdanovich, V. I.; Anisimov, K. N. (Inst. for Organoelementary Compounds, Moscow). Dokl. Akad. Nauk SSSR; 190: 1103-5(11 Feb 1970). (In Russian).

It has been established that arene chromium tricarbonyl compounds are able to participate in an electrophilic isotopic hydrogen exchange in highly acid media; the chromium tricarbonyl group decreases the nucleophilic character of the compound sharply. In order to study the effects of strong p-donor ligands on the reactivity of the aromatic ring, the isotopic exchange, H to D reaction in an acid medium of several arene chromium tricarbonyls were investigated. It was found that substitution of a carbonyl group by triphenylphosphine increases the nucleophilic character of the aromatic ligand sharply. The rate of the hydrogen exchange reaction in acid medium of mesitylene was found to be seven fold higher than that of benzene but mesitylene chromium dicarbonyl triphenylphosphine is only slightly more reactive than the corresponding benzene compound. The protons of methyl and methoxyl groups bound to benzene rings are less sensitive toward the triphenylphosphine group. (TTT)

38820 STABILITY CONSTANTS OF FLUORIDE AND SULPHATE COMPLEXES OF NEPTUNIUM(V) AND NEPTUNIUM(VI). Al-Niaimi, N. S.; Wain, A. G.; McKay, H. A. C. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem.; 32: 2331-42(Jul 1970).

Stability constants of the fluoride and sulphate complexes of neptunium (V) and (VI) were determined in $HClO_4$ at concentrations ranging from 0.1 to 0.5 M by measuring the potentials of chemical cells containing equimolar proportions of Np (V) and Np (VI) along with varying concentrations of the complexing ligands. The valency of the neptunium was adjusted by controlled potential coulometry. Computer analysis of the results and extrapolation of the stability constants to infinite dilution gave the following values at 25 ± 0.01°C. Fluoride system: ${}^0\beta_1 = ([NpO_2F^+][H^+])/([NpO_2^{2+}][HF]) = 25.6^{+1.2}_{-1.4}$ and ${}^0K_2 = ([NpO_2F_2][H^+])/([NpO_2F^+][HF]) = 1.1 \pm 0.1$. Sulphate system: ${}^0\beta_1 = ([NpO_2SO_4][H^+])/([NpO_2^{2+}][HSO_4^-]) = 18.9^{+3}_{-4}$. There was no evidence of formation of neptunium (V) fluoride or sulphate complexes. (auth) (UK)

38821 ELECTROCHEMISTRY OF BERKELIUM IN ACIDIC AQUEOUS SOLUTION. Propst, R. C.; Hyder, M. L. (E. I. du Pont de Nemours and Co., Aiken, S. C.). J. Inorg. Nucl. Chem.; 32: 2205-16(Jul 1970).

The Bk(IV/III) couple was studied electrochemically at the conducting glass electrode in 0.10N sulfuric acid solution. Results enable the calculation of the formal potential (+1.43V) for the couple, and of the rate of reduction of Bk^{4+} by water in this solution: $d[Bk^{4+}]/dt = (2.4 \pm 0.7) \times 10^{-4}[Bk^{4+}]\ sec^{-1}$. The rate of Bk^{4+} reduction by autoradiolysis was also measured. The Bk(IV/III) couple is reversible, indicating that controlled potential coulometry is potentially useful for the determination of this element. However, the autoradiolysis process is highly sensitive to trace amounts of organic impurities. (auth) (UK)

38822 NEPTUNYL(VI)-ACETATE COMPLEXES IN AQUEOUS SOLUTION. Portanova, R.; Tomat, G.; Magon, L.; Cassol, A. (CNR, Padua). J. Inorg. Nucl. Chem.; 32: 2343-8(Jul 1970).

Complex formation by neptunyl (VI) with acetate was investigated by means of potentiometric $[H^+]$ measurements and values of the complexity constants of the three mononuclear complexes determined in perchlorate medium of ionic strength I = 1M at 20°C. Comparison with the available constants for acetate complexes of uranyl (VI) and plutonyl (VI) is discussed. (auth) (UK)

38823 KINETICS OF ISOTOPIC EXCHANGE OF NITROGEN BETWEEN AMMONIA AND ITS COMPLEXES WITH ALCOHOLS. Kuznetsov, A. I.; Panchenkov, G. M. (Moscow State Univ.). Zh. Fiz. Khim.; 44: 1116-18(Apr 1970). (In Russian).

The kinetics of isotopic exchange of nitrogen between ammonia and its complexes with saturated aliphatic alcohols were studied. The apparatus used is described. Rapid isotopic exchange occurs, which lasts for 2 to 5 min. Moreover, the actual rate of isotopic exchange of the nitrogen under the conditions of these experiments is limited by the rate of stirring ammonia in the gas stream. (tr-auth)

38824 CRYSTAL STRUCTURE OF β-TETRAKIS(ACETYLACETONATO)URANIUM(IV). Titze, Heinz (Technische Hochschule, Goteborg. Univ. of Goteborg). Acta Chem. Scand.; 24: 405-14(1970). (In German).

The crystal structure of β-tetrakis-(acetylacetonato)-uranium(IV) was determined by x-ray methods. The unit cell is monoclinic (space group C2/c), with lattice parameters: a = 22.021 Å, b = 8.390 Å, c = 14.486 Å, β = 115.72° and Z = 4. A total of 934 independent structure factors was used for the analysis. The structure was defined on the basis of the isomorphous cerium compound. The refinement of the atomic positions and anisotropic temperature parameters, by the least squares method gave a value of 0.088 for the R-factor. The uranium atom is coordinated by 8 oxygen atoms in the form of an Archimedean antiprism. The mean of the uranium-oxygen distances is 2.32 Å with a standard deviation ±0.03 Å. The acetylacetonate rings are bent about a line joining the oxygen atoms. For ligand 1 the angle is 59°, and for ligand 2 it is 14°. (auth)

38825 NEUTRON DIFFRACTION STUDY OF MOLECULAR MOTION IN SOLID DEUTERIUM CHLORIDE. Sandor, E.; Farrow, R. F. C. (Queen Mary Coll., London). Discuss. Faraday Soc.; No. 48, 78-86(1969).

Mean square thermal displacements of the chlorine and deuterium atoms were derived both in the ordered orthorhombic and in the disordered cubic phase of deuterium chloride by a least-squares study of the neutron powder diffraction patterns recorded at four temperatures over the 4.2 to 111.5 K range. The atomic displacements were subsequently interpreted as due to the superposition of the internal stretching vibrations and of the rigid-body translational and angular vibrations of the molecules. The analysis of the results revealed substantial rigid-body vibrational components in the zero-point motion of the molecules and a rapid rise in the amplitude of the in-plane angular vibrations on approaching the transition point. It also showed a small but possibly significant lengthening of the Cl-D bond as the temperature decreases. Finally, it gave a fuller understanding of the disordered cubic phase as a dynamic mixture of short-lived polymers of varying lengths and shapes. (auth) (UK)

38826 APPLICATIONS OF ISOTOPE EFFECTS. Gold, V. (King's Coll., London). Chem. Brit.; 6: 292-5(Jul 1970).

A brief history of the discovery and separation of isotopes is given. The origin of thermodynamic and kinetic isotope effects and the application of the exchange equilibrium involved to isotope separation are discussed. The primary kinetic isotope effects and their applications to the investigation of organic reaction substances, the development of autoxidation resistant lubricating oil for watches and the prolongation of periods of drug effectiveness are considered and heavy water and its use as a reactor moderator discussed. (UK)

38827 HOMOGENEOUS AND HETEROGENEOUS METAL-CATALYSED ISOTOPIC HYDROGEN EXCHANGE IN ALKYLBENZENES. MECHANISM OF ALKYL DEUTERIATION IN ETHYLBENZENE. Garnett, J. L.; Kenyon, R. S. (Univ. of New South Wales, Kensington, Australia). J. Chem. Soc., D; No. 11, 698-9(1970).

Homogeneous and heterogeneous metal-catalysed isotopic hydrogen exchange in the alkyl group of [β-^{14}C]ethylbenzene showed that predominant deuteration does not occur via previously suggested mechanisms involving reversible dealkylation or carbonium ion intermediates: instead a π-allylic process is suggested. (auth) (UK)

38828 STUDY OF THE INFLUENCE OF DEUTERIUM SUBSTITUTION ON THE HYDROGEN BOND OF DIMERIC FORMIC ACID. Almenningen, A.; Bastiansen, O.; Motzfeldt, Tove Univ. of Oslo). Acta Chem. Scand.; 24: 747-8(1970).

In a search for a possible isotope effect on the hydrogen bond, the gas electron-diffraction technique was used to study the structure of formic acid dimer where the hydroxyl hydrogen has been substituted by deuterium. The distances and angles are obtained by least squares refinement with an experimental diagonal weight matrix and compared with results of earlier structure determination of formic acid. The only significant difference is found for the hydrogen bond length which gives a value for $(HCOOD)_2$ 0.019 Å larger than for $(HCOOH)_2$. This value is in good agreement with that observed on α-oxalic acid dihydrate. (Denmark)

38829 MICROWAVE SPECTRUM AND INTRAMOLECULAR HYDROGEN BONDING IN 2-FLUOROETHANOL. Buckton, Keith S.; Azrak, Raymond G. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 52: 5652-6(1 Jun 1970).

The microwave spectra of two isotopic species of 2-fluoroethanol (FCH_2CH_2OH and FCH_2CH_2OD) were analyzed to yield some information about a proposed intramolecular hydrogen bond in the molecule. A molecular structure was derived which reveals that the most stable rotamer is that which allows close approach of fluorine and hydrogen atoms. The F ... H distance is 2.42 ± 0.02 Å; the dihedral angle FCCO is 62°12′ ± 1.0°, and the dihedral angle CCOH is 55°30′ ± 3°. The dipole moment components are μ_a = 0.38 ± 0.02 D, μ_b = 1.47 ± 0.01 D, and $\mu_c \approx$ 0.0 D; these are consistent with bond moment calculations. A vibrational state attributed to the CC torsional motion was assigned and determined to be 152 ± 10 cm^{-1} above the ground state. Results suggest a hydrogen–fluorine interaction which does not grossly distort the normal molecular charge distribution. (auth)

38830 CARBON AND OXYGEN ISOTOPE EFFECTS IN THE DECARBONYLATION OF BENZOYLFORMIC ACID IN CONCENTRATED SULPHURIC ACID. Margolin, Z.; Samuel, D. (Weizmann Inst. of Science, Rehovoth, Israel). J. Chem. Soc., D; No. 13, 802-3(8 Jul 1970).

Kinetic isotope effects for carbon and oxygen for the decarbonylation of benzoylformic acid in concentrated sulphuric acid were measured, which, together with measurements on isotopic exchange of oxygen with the solvent, support a mechanism in which C–O bond rupture occurs in the rate-determining step. (auth) (UK)

38831 OXIDATION OF 4a,4b-DIHYDROPHENANTHRENE. IV. KINETIC ISOTOPE EFFECT OF DEUTERIUM IN THE PROPAGATION AND THE INITIATION STEPS. Bromberg, A.; Muszkat, K. A.; Warshel, A. (Weizmann Inst. of Science, Rehovot, Israel). J. Chem. Phys.; 52: 5952-9(1 Jun 1970).

A kinetic isotope effect was found in one of the propagation steps of the reaction of perdeutero-4a, 4b-dihydrophenanthrene (PH_3) with O_2. In this step, $PH_3 + HO_2\cdot \rightarrow PH\cdot + H_2O_2$, the kinetic isotope effect is 7.2 at −10°C and 9.9 at −31°C. The theoretical calculation by the previously described method predicts for this step an isotope effect of the correct magnitude. The success of the same method, using a similar theoretical model, for the treatment of reactions involving widely different extents of tunneling is a good indication to the validity of the isotope effect calculations and supports the previous conclusions about the exceptional importance of tunneling in the initiation step. As tunneling is relatively unimportant in the propagation step, the kinetic isotope effect is markedly reduced compared to its value in the initiation step. Hence, the kinetic isotope effect is significantly reduced compared to that in the initiation step. The ratio between the pre-exponential factors in the initiation step for the oxidation of the perhydro and perdeutero compounds is discussed. Bell's criterion for reactions involving tunneling is $A^D/A^H \gg 1$, while in the initiation step the ratio is close to unity. It is concluded that in reactions with a significant tunneling effect the ratio A^D/A^H may vary within limits, being less than, equal to, or greater than unity. (auth)

38832 DISSOCIATION CONSTANTS OF AMINO ACIDS IN DEUTERIUM OXIDE. Gordon, I. N.; Lowe, B. M. (Univ. of Edinburgh). J. Chem. Soc., D; No. 13, 803-4(8 Jul 1970).

The isotope effect log K_H/K_D for the first dissociation constants of the amino acids in the series $H_3N^+[CH_2]_xCO_2H$, $1 \leq x \leq 5$, and $[CH_3]_yN^+H_{3-y}CH_2CO_2H$, $0 \leq y \leq 3$, shows a good linear correlation with pK_H. (auth) (UK)

38833 RADIOCHEMICAL INVESTIGATIONS OF THE CORROSION OF BRASS. Poetzl, Rudolf; Lieser, Karl Heinrich (Eduard-Zintl Institut, Darmstadt, Ger.). Z. Metallk.; 61: 527-34(Jul 1970). (In German).

The mechanism of dezincification of 60–40 brass in sodium chloride solution (0.1 m) and 70–30 brass in sodium sulfate (1.0 m) and sodium chloride solutions (0.1 m and 1.0 m) was investigated radiochemically. It was shown that dezincification of both alloys is essentially due to a redeposition of copper. The investigation of the heterogeneous isotope exchange of copper ions of 70–30 brass in 0.1 m sodium chloride solution yielded that adsorption is the main process of Cu-64 deposition. Less than 0.1 atomic layers of the metal surface participate in the ion exchange. Zn-65 is not deposited to any great extent. The fraction is about the same under corroding and noncorroding conditions. (auth)

38834 KINETIC SOLVENT ISOTOPE EFFECT, SOLVENT REORGANIZATION, AND THE S_N1–S_N2 MECHANISM. Treindl, L.; Robertson, R. E.; Sugamori, S. E. (National Research Council of Canada, Ottawa). Can J. Chem.; 47: 3397-3404(15 Sep 1969).

The temperature dependence of the rates of solvolysis was determined in D_2O for t-butyl chloride, 2,2-dibromopropane, 2-bromo-2-chloropropane, and 2-chloro-2-methylpropyl methyl ether, and corresponding values of $\Delta H^{\ddagger}$, $\Delta S^{\ddagger}$, and $\Delta C_p^{\ddagger}$ are derived. Values of $\Delta H^{\ddagger}$ and $\Delta S^{\ddagger}$ from the solvolysis of seven other halides and two benzenesulfonates were estimated from rate determinations at two temperatures in D_2O. A comparison of these values with terms from corresponding experiments in H_2O provides values of $\delta_1\Delta G^{\ddagger}$, $\delta_1\Delta H^{\ddagger}$, and $\delta_1\Delta S^{\ddagger}$ characterizing the kinetic solvent isotope effect. While $\delta_1\Delta G^{\ddagger}$ appears to have about the same value for a wide range of halides of different structure irrespective of the probable mechanism of reaction, systematic differences in $\delta_1\Delta H^{\ddagger}$ and $\delta_1\Delta S^{\ddagger}$ differentiate those reacting by an S_N2 mechanism from those reacting by an S_N1 mechanism. This difference is in the direction suggesting a loosening of solvent structure in the activation process in agreement with indications obtained from the corresponding values of the heat capacity of activation. (auth) (Canada)

38835 CEMENTATION OF MICROQUANTITIES OF POLONIUM BY MERCURY. Gladyshev, V. P.; Enikeev, R. Sh.; Nauryzbaev, M. K. Radiokhimiya; 12: 195-7(1970). (In Russian).

Experiments were conducted on the reduction of polonium by mercury from 0.1 and 1N solutions of nitric, sulfuric, hydrochloric, chloric, hydrobromic, and hydriodic acids. Kinetic curves are given for the reduction of Po in 1N acid solutions. In solutions of the halogen acids, reduction proceeds slightly more rapidly. Complete transition of Po in the mercury phase was observed during Po extraction from acid media of 0.1 to 10N. (R.V.J.)

38836 STUDY OF THE ISOTOPIC EXCHANGE BY PERIPHERAL ATOMS IN HALIDE DERIVATIVES OF AROMATIC COMPOUNDS OF TELLURIUM. Nefedov, V. D.; Sinotova, E. N.; Sarbash, A. N. Radiokhimiya; 12: 192-4(1970). (In Russian).

Isotopic exchanges between chloride, bromide, and iodide derivatives of tellurium, and the corresponding potassium or sodium halides in H_2O–$CHCl_3$, and exchanges between diphenyitellurium iodide and molecular iodine in chloroform were studied. Indicators used were ^{36}Cl, ^{82}Br, and ^{131}I. (R.V.J.)

38837 CERTAIN PROPERTIES OF REACTIONS OF THERMAL DISSOCIATION OF SOLID OXIDES. Malinin, G. V.; Tolmachev, Yu. M. Radiokhimiya; 12: 183-6(1970). (In Russian).

The irreversibility of the thermal decomposition reaction of certain oxides is discussed. During the first type of reaction, atomic oxygen is emitted. The second type of reaction produces only molecular oxygen. The reaction α-$UO_{3-x} \rightarrow U_3O_8$ is related to the second type of reaction, and at low pressures of oxygen remains irreversible. (tr-auth)

38838 STANDARD ENTHALPY OF FORMATION OF URANIUM TRIFLUORIDE. Khanaev, E. I.; Khripin, L. A. Radiokhimiya; 12: 178-81(1970). (In Russian).

The heat of solution of crystalline uranium trifluoride was determined in concentrated HCl containing 10% $FeCl_3$ and 1% H_3BO_3 at 50°C. Heats of solution were also determined under the same conditions for anhydrous crystalline uranium tetrachloride, uranyl chloride, and iron chloride. Results of two methods for calculation

of the enthalpy of formation of uranium trifluoride are $\Delta H^0_{f298} = -358 \pm 4$ and $\Delta H^0_{f298} = -355 \pm 6$ kcal/mole. (tr-auth)

38839 STABILITY OF THE COMPLEXES OF THORIUM AND URANIUM(IV) WITH ANIONS OF DICARBOXYLIC ACIDS. Merkusheva, S. A.; Kumok, V. N.; Skorik, N. A.; Serebrennikov, V. V. Radiokhimiya; 12: 175-8(1970). (In Russian).

A solubility method was used to determine the precipitated salts of thorium and uranium(IV) in succinic, glutaric, adipic, and azelaic acids, of the composition $(MOH)_2A_3 \cdot nH_2O$. Stability constants for complexes of the type, MA^{2+} and MA_2 were also determined. (tr-auth)

38840 DEUTERO[18]ANNULENE. Wolovsky, R. (Weizmann Inst. of Science, Rehovoth, Israel); Woo, E. P.; Sondheimer, F. Tetrahedron; 26: 2133-9(May 1970).

Partial catalytic deuteration of 1,7,13-tridehydro[18]annulene (1) led to deutero[18]annulene, consisting mainly of [18]annulene-d_3. It was shown that the recovered 1 contained some deuterium. The integrated areas of the outer : inner proton bands in the NMR spectrum of the deutero[18]annulene were found to be ca. 2 : 1, as in [18]annulene (2) itself. An explanation for this phenomenon is given, taking into account the conformational mobility of 2. Catalytic deuteration of 1, 2 and deutero[18]annulene gave deuterocyclooctadecanes, extensive hydrogen–deuterium exchange having occurred in each case. (auth) (UK)

38841 STABILITY OF AMINE SOLUTIONS DURING STRATIFICATION INTO TWO PHASES. Zemlyanukhin, V. I.; Zakharkin, B. S. Radiokhimiya; 12: 76-85(1970). (In Russian).

The physicochemical properties of systems of trioctylamine–diluent (kerosene, polyalkylbenzene, carbon tetrachloride, and xylene) were studied considering their stability in the formation of the second organic phase. Maximum concentrations of HNO_3, U(VI), Np(IV), and Pu(IV) in organic solutions were studied as functions of the concentration of TOA in the diluents. (R.V.J.)

38842 KINETICS OF SPONTANEOUS OXIDATION OF TRIVALENT URANIUM IN CHLORIDE SOLUTIONS. Peretrukhin, V. F.; Krot, N. N.; Gel'man, A. D. Radiokhimiya; 12: 96-101(1970). (In Russian).

The rate of oxidation of uranium(III) in chloride solutions in the absence of oxygen was studied. Oxidation rates were determined at room temperature in concentrations of 10^{-4} to 8M HCl and in 0.5M HCl with LiCl concentrations from 0 to 9.5M. It was found that the oxidation rate is at its minimum in 0.2 to 0.5M HCl (1.5% U after a period of days) and increases upon an increase as well as a decrease in acidity, and upon additions of LiCl. With a 10°C increase in temperature the reaction rate in 6M HCl increased 1.7-fold and in 0.5M HCl, not more than 2-fold. Activation energy of the reaction in 6M HCl was 9.9 kcal/mole, and in 0.5M HCl, not more than 13 kcal/mole. (tr-auth)

38843 EFFECT OF ANIONS ON THE KINETICS OF SPONTANEOUS OXIDATION OF TRIVALENT URANIUM IN AQUEOUS SOLUTIONS. Peretrukhin, V. F.; Krot, N. N.; Gel'man, A. D. Radiokhimiya; 12: 101-5(1970). (In Russian).

Rate constants were determined for the oxidation of uranium(III) in perchloric and sulfuric acids in weakly acid acetate solutions in the presence of ammonium sulfate and EDTA. The minimum oxidation rate was observed in 0.25M H_2SO_4. The reaction rate increases with an increase or decrease (up to pH > 3) in H_2SO_4 concentration. (tr-auth)

38844 CRYSTAL STRUCTURE OF NiU_2O_6 AND CoU_2O_6. Kemmler-Sack, S. (Univ., Tuebingen, Ger.). Z. Anorg. Allg. Chem.; 358: 226-32(May 1968). (In German).

CoU_2O_6 and NiU_2O_6 crystallize hexagonally with a = 9.09$_5$, c = 4.99$_6$ Å, and a = 9.01$_5$, c = 5.10$_3$ Å, respectively, Z = 3, space group D^3_3 – P321 (Na_2SiF_6 structure). (auth)

38845 STUDY OF ISOTOPIC EFFECTS AND DETERMINATION OF THE QUADRUPOLE COUPLING CONSTANT FROM THE NUCLEAR MAGNETIC RESONANCE SPECTRA OF MONODEUTEROBENZENE IN A NEMATIC PHASE. Diehl, P.; Khetrapal, C. L. (Univ., Basel). Can. J. Chem.; 47: 1411-6(15 Apr 1969).

The proton and the deuteron magnetic resonance spectra of monodeuterobenzene were studied in the nematic phase of a mixture of 50% 4-methoxybenzylidene-4-amino-α-methyl cinnamic acid-n-propyl ester and 50% anisole–azophenyl-n-capronate at room temperature. The proton spectrum was studied as a superposition of three 5-spin sub-spectra due to coupling with one deuteron (spin I = 1) and analyzed iteratively as a 7-spin system, treating the deuteron as two spin ½ particles. The values of the dipole–dipole couplings show minor but significant deviations due to isotopic substitution, from those expected for the regular hexagonal geometry. Two parameters are necessary to define molecular orientation. The ratio of the two orientation parameters is reported. The ratios $(r_{HD}/r_{HH})_{ortho}$ and $(r_{CH} - r_{CD})/(r_{HH})_{ortho}$ are obtained. They indicate a reduction in the time average value of the C–D bond length compared to the C–H one. It is suggested that the orientation parameters from the proton spectrum of the molecule are used in order to determine the deuteron quadrupole coupling constant from deuteron magnetic resonance (dmr) spectra of partially deuterated molecules dissolved in the nematic phase. The method was applied, and its limitations and sources of errors are discussed. (auth) (Canada)

38846 URANYL PHENOXIDES. Funk, H.; Andrae, K. (Martin-Luther-Univ., Halle, Ger.). Z. Anorg. Allg. Chem.; 362: 93-7(Oct 1968). (In German).

Syntheses of uranyl phenoxide compounds by reaction of phenol and substituted phenols with UO_2Cl_2 or $UO_2(CH_3COO)_2$ and amines are described. (auth)

38847 ISOTOPIC EFFECT ON THE MELTING POINT OF LITHIUM NITRATE. Jansson, Bert; Lunden, Arnold (Chalmers Inst. of Tech., Goteburg). Z. Naturforsch.; 25a: 697-9(May 1970).

The techniques of segregation during normal freezing and of zone melting were used to establish that the melting point of $^6LiNO_3$ is higher than that of $^7LiNO_3$. The difference is of the order of 0.03°C. The isotope shift of the melting point is in the opposite direction of the isotope effects found previously for phase transitions in solid lithium metal and lithium sulfate. For the latter salt a recalculation based on a more accurate value for the self-diffusion coefficient shows that the temperature of transition at about 575°C to a fcc structure is about 0.08 degree lower for $^6Li_2SO_4$ than for $^7Li_2SO_4$. (auth)

38848 HEPTAVALENT STATE OF TRANSURANIC ELEMENTS. VII. THE STABILITY OF NEPTUNIUM(VII) IN ACID SOLUTIONS. Shilov, V. P.; Krot, N. N.; Gel'man, I. A. Radiokhimiya; 12: 222-7(1970). (In Russian).

The kinetics and mechanism of reduction of neptunium(VII) in pure nitrate and perchlorate solutions, and in the presence of certain anions and cations, were studied. Np(VII) in nitric and perchloric acid solutions is unstable and is reduced by water at 25 to 44°C by first order reactions relative to the metal. The effects of H^+ concentration, ionic force, and temperatures on the rate of this process were studied. The activation energy of the reaction was determined to be 16 ± 1 kcal/mole (μ = 1.0, $[H^+]$ = 0.01 to 1.0 g ion/l). It was established that PO_4^{3-}, SO_4^{2-}, and BrO_3^- ions have little effect on the rate of reduction of Np(VII) in acid media. The Np(VII) is instantaneously reduced in ethanol, HCOOH, $H_2C_2O_4$, tartaric and citric acids, EDTA, HNO_2, IO_3^-, I^-, and Br^-. Acetic acid and chloride ions react with Np(VII) at a moderate rate. The effect of $S_2O_8^{2-}$ depends on the concentration of H^+ ions. The reduction of NpO_4^{3+} ions by water is catalyzed by trace Fe, Ni, Co, Ag, and Pt impurities. (tr-auth)

38849 HEPTAVALENT STATE OF TRANSURANIC ELEMENTS. VIII. THE STABILITY OF PLUTONIUM(VII) IN ALKALINE MEDIA. Komkov, Yu. A.; Krot, N. N. Radiokhimiya; 12: 227-32(1970). (In Russian).

Spectrophotometric studies were made on the kinetics of reduction of plutonium(VII) by water in dilute alkaline solutions. The rate of reduction is described by the equation of the fractional order reaction relative to plutonium(VII). The effects of temperature and OH ions on the stability of Pu(VII) were studied. The reduction of Pu(VII) is accelerated by cobalt, iron, copper, and nickel compounds. (tr-auth)

38850 HEPTAVALENT STATE OF TRANSURANIC ELEMENTS. IX. CONCERNING NEW COMPOUNDS OF NEPTUNIUM(VII). Mefod'eva, M. P.; Krot, N. N.; Gel'man, A. D. Radiokhimiya; 12: 232-7(1970). (In Russian).

A new crystalline compound of neptunium(VII), with the composition $[CoEn_3]\ NpO_3 \cdot 3H_2O$ (where En = ethylenediamine), was isolated in the solid form. The compound dissolves comparatively well in alkaline solutions and on storage in the dry form gradually decomposes with the transition of neptunium to the heptavalent state. The formation of a complex of NpO_4^{3+} with sulfate ions in perchloric acid was studied spectrophotometrically. At concentrations of Na_2SO_4 up to 7×10^{-2}M and μ = 1.0, the complexes $NpO_2SO_4^+$ and $NpO_2(SO_4)_2^-$ were formed and their stability constants were found to equal 1.6×10^2 and 1.1×10^4, respectively. Conditions were determined at which neptunyl ions form precipitates with phosphate and periodate ions. The compounds rapidly decomposed with transition of the Np(VII) to the hexavalent form. (tr-auth)

38851 KINETICS OF OXIDATION BY OZONE OF Np(VI) TO Np(VII) IN ALKALINE SOLUTIONS. Shashukov, E. A.; Kozlov, A. A. Radiokhimiya; 12: 237-42(1970). (In Russian).

On oxidation of Np(VI) (~10^{-5} g atom/l) to Np(VII) by ozone in

solutions of 1 to 4M KOH at 0 to 20°C, the rate of the reaction is described by the equation: $(d[Np(VII)])/(dt) = K[Np(VI)]\,[OH^-]^{0.5}\,[O_3]^{0.5}$. The activation energy of the oxidation of Np(VI) by ozone is approximately equal to 5 kcal/mole. Possible reaction mechanisms are considered. (tr-auth)

38852 RATNER FORMULA AND CERTAIN NEW EQUATIONS. Egorov, Yu. V. Radiokhimiya; 12: 243-53(1970). (In Russian).

The rules of secondary adsorption of radioactive microcomponents, such as ^{212}Pb and ^{228}Ac, by polar crystals were analyzed. It was concluded that the nonlinearity of the diagram of the Ratner isotherm is either the consequence of an increased theoretical sphere of action or of the utilization of two different electrolytes with the proper ions and incorrect treatment of experimental data. The formula that linearly connects the logarithms of the secondary adsorption coefficients of the microcomponents and the concentration on the ions in solution in many cases correlates better than the Ratner equation. (tr-auth)

38853 COLLOIDAL STATE OF Pu(IV) IN AQUEOUS SOLUTIONS. Sheidina, L. D.; Kovarskaya, E. N. Radiokhimiya; 12: 253-9(1970). (In Russian).

On the basis of a study of Pu(IV) in aqueous solutions in a concentration range from 10^{-6} to 10^{-10}M, it was concluded that the polymerization of plutonium is the cause of displacement of the maximum of the sorption curve characterized by the beginning of formation of the hydroxide at higher values of pH on transition from the microconcentrations of the element to concentrations on the order of 10^{-6}M. (tr-auth)

38854 INVESTIGATION OF COMPLEX FORMATION IN SOLUTIONS BY DETERMINATION OF MAGNITUDE OF CHARGE OF ANIONIC COMPLEXES BY ION EXCHANGE METHOD. Petrzhak, G. I.; Stepanova, L. N.; Karago, L. V. Radiokhimiya; 12: 266-72(1970). (In Russian).

The possibility of using the ion exchange method for determination of the magnitude of charge of anions for study of processes of complex formation in solutions of complexes with K_H from 10^{-28} to 10^{-3} was studied. It was discovered that the isomorphous crystalline oxalates $U(C_2O_4)_2 \cdot 6H_2O$ and $Th(C_2O_4)_2 \cdot 6H_2O$ behave differently in aqueous solutions and in solutions of oxalic acid. At concentrations of 10^{-3} to 10^{-4}M of U(IV), Th, and Np(IV) in oxalate solutions, the coordinationly saturated complex anions $[Me(C_2O_4)_4]^{4-}$ are formed. The behavior of the compound $K_2U_2(C_2O_4)_5 \cdot 8H_2O$ was studied in various solutions. (tr-auth)

38855 SOLUBILITY OF COMPLEX SALTS OF HEXANITRATOTHORATES WITH QUATERNARY AMMONIUM BASES IN SOLUTIONS OF NITRIC ACID. III. THE RELATION OF SOLUBILITY TO THE CONCENTRATION OF NITRIC ACID. Nikol'skii, B. P.; Markov, G. S.; Posvol'skii, M. V. Radiokhimiya; 12: 272-8(1970). (In Russian).

The solubility of $(DMDBA)_2[Th(NO_3)_6]$, where DMDBA is dimethyldibenzylammonium, in solutions of nitric acid at concentrations of 2 to 10M and at 25°C was studied. It was established that the appearance of a minimum in the solubility curve of the salt is caused mainly by the formation in solution of solvated forms of the quaternary base. The nature of the cation has an effect on the position of the minimum in the solubility curve in agreement with the ability of cations to form solvated forms with nitric acid. (tr-auth)

38856 THORIUM OXALATE COMPLEXES. Grebenshchikova, V. I.; Bryzgalova, R. V.; Rogozin, Yu. M. Radiokhimiya; 12: 279-86(1970). (In Russian).

The possibility of determining the composition and instability constants of thorium oxalate complexes by the method of ligand displacement is discussed. Thoron is recommended as the auxiliary ligand. Depending on the composition of the nitric acid–oxalic acid solution, the complex may be either $[Th(C_2O_4)]^{2+}$ or $[Th(C_2O_4)]^0$. The instability constants of these two complexes are 2.8×10^{-9} and 2.7×10^{-16}, respectively. (tr-auth)

38857 SOLUBILITY OF THORIUM OXALATE IN MIXED SOLUTIONS OF NITRIC AND OXALIC ACIDS. Bryzgalova, R. V.; Rogozin, Yu. M.; Chernitskaya, I. V. Radiokhimiya; 12: 286-91 (1970). (In Russian).

The solubility of thorium oxalate was determined in nitric acid and mixtures of nitric and oxalic acids. The instability constants of the first and second thorium oxalate complexes were estimated to be 1.6×10^{-9} and 4.3×10^{-16}, respectively, in good agreement with the method of ligand displacement. (tr-auth)

38858 INDUCED REACTIONS IN RADIOCHEMISTRY. II. CATALYSIS OF THE INDUCED OXIDATION OF PLUTONIUM BY CHROMIUM(VI). Posvol'skii, M. V.; Tsirlin, I. I. Radiokhimiya; 12: 361-6(1970). (In Russian).

The catalytic effects of various elements on the induced oxidation of plutonium(IV) were studied. Two simultaneous reactions and the formation of two intermediate forms of chromium are considered and a possible mechanism for the action of catalysts is postulated. (tr-auth)

38859 INDUCED REACTIONS IN RADIOCHEMISTRY. III. EFFECT OF PRODUCTS OF RADIOLYSIS ON COURSE OF INDUCED REACTIONS. Posvol'skii, M. V.; Tsirlin, I. I.; Kochnov, V. A. Radiokhimiya; 12: 367-73(1970). (In Russian).

It is shown that the traditional method for determination of the maximum induction factor is not suitable for solutions of radioactive substances. The effects of products of radiolysis in the solution caused by radiations from the radioactive material must be considered. It is shown that the so-called "straight-line" oxidation of plutonium(IV) by chromic acid at room temperature is, to a significant degree, caused by the simultaneously proceeding reaction Cr(VI) + HNO_2 + Pu(IV). Nitrous acid has a higher rate of reaction with chromium than with plutonium. (tr-auth)

38860 PHENOXIDE COMPOUNDS OF TETRAVALENT URANIUM. Funk, H.; Andrae, K. (Martin-Luther-Univ., Halle, Ger.). Z. Anorg. Allg. Chem.; 361: 199-202(Sep 1968). (In German).

Syntheses of phenoxide compounds of uranium(IV) by reaction of phenols with UCl_4 or $UOCl_2$ in tetrahydrofuran and benzene are described. (auth)

38861 PYROLYSIS OF NITROMETHANE-d_3. Crawforth, C. G.; Waddington, D. J. (Univ. of York, Eng.). J. Phys. Chem.; 74: 2793-6(9 Jul 1970).

The pyrolysis of nitromethane-d_3 between 300 and 400°C was studied and results compared with the pyrolysis of nitromethane. It is shown that there is a deuterium isotope effect, which may be ascribed to the reactions: $CD_3\cdot + CD_3NO_2 \rightarrow \cdot CD_2NO_2 + CD_4$ (3a), $CD_3O\cdot + CD_3NO_2 \rightarrow \cdot CD_2NO_2 + CD_3OD$. (auth)

38862 KINETICS OF THE URANIUM(III)–URANIUM(VI) AND THE NEPTUNIUM(III)–NEPTUNIUM(VI) REACTIONS IN AQUEOUS PERCHLORATE SOLUTIONS. Newton, T. W.; Fulton, R. B.; (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem.; 74: 2797-2801(9 Jul 1970).

The kinetics of the reactions $M^{3+} + MO_2^{2+} = M^{4+} + MO_2^+$, where M = U or Np, were studied in aqueous perchlorate solutions. For both reactions the hydrogen ion dependence is not significant and the rate law is $-d[M^{3+}]/dt = k[M^{3+}][MO_2^{2+}]$. At 25°C in 0.1 M $HClO_4$, $k_U = 1.1 \times 10^4$ M^{-1} sec^{-1} and $k_{Np} = 2.2 \times 10^4$ M^{-1} sec^{-1}. Temperature dependence data lead to $\Delta H^{\ddagger}_U = 4.15 \pm 0.07$ kcal/mol and $\Delta H^{\ddagger}_{Np} = 0.96 \pm 0.11$ kcal/mol. The ionic strength dependence for the uranium reaction was studied between 0.05 and 1.0 M and found to be in accord with the extended Debye–Hückel equation. (auth)

38863 HETEROGENEOUS ISOTOPIC EXCHANGE AT THE INTERFACE OF STEEL SHEETS IN CONTACT WITH IRON CHLORIDE SOLUTIONS. II. EXPERIMENTS WITH IRON(III) CHLORIDE AND IRON(II) AMMONIUM SULFATE SOLUTIONS. Farkas, J.; Nagy, L. G.; Varsanyi, Gy. (Technical Univ., Budapest). Period. Polytech. Chem. Eng.; 13: No. 4, 297-316 (1969).

Isotopic exchange was measured on pretreated (mechanical and short alkaline treatment) commercial low-alloy steel surfaces, in aqueous ferric chloride and Mohr's salt solutions, at room temperature, as a function of time. The surface fineness of the plates used in the investigations was determined experimentally, and from these values conclusions were drawn on the basis of proportionality of the magnitude of the actual surface. It was established that isotopic exchange without a change in the metal surface (structural transformations, corrosion, etc.) takes place only over a certain percentage of the actual metal surface, and involves not more than a monomolecular surface layer. The exchange vs. time can be represented by the kinetic equation $\lg x = a \cdot \lg t + b$. Presumably, the rate determining process is the diffusion of iron ions in the solution. (auth)

38864 AQUEOUS COORDINATION COMPLEXES OF PLUTONIUM. Cleveland, J. M. (Dow Chemical Co., Golden, Colo.). Coord. Chem. Rev., 5: 101-37(Apr 1970).

This review of Pu complex chemistry is concerned solely with Pu complexes in aqueous solution; the compounds are discussed only when used to establish the identity of species in solution. The organic-soluble complexes formed between Pu and organophosphorus compounds and organic amines are not discussed. Complexes of various oxidation states of Pu with the following ligands are discussed: fluoride, chloride, bromide, nitrate, sulfate, sulfamate, phosphate, peroxide, carbonate, acetate, oxalate, lactate, glycine, citrate, tartrate, ethylenediamine, and acetylacetone are cited. (125 references) (B.L.M.)

38865 COMPLEXES OF URANYL ION WITH SOME AMINO AND MERCAPTO ACIDS. Raghavan, A.; Santappa, M. (Univ. of Madras). Curr. Sci. (India); 39: 302-3(5 Jul 1970).

Aqueous pH titrations were carried out with 0.1 μM $NaClO_4$ on systems of uranyl ions with cysteine, methionine, N-acetylglycine, and thiosalicylic acid to determine the composition(s) and stability constant(s) of the complex(es) formed. Dissociation constants were determined by conventional methods for the amino acids and by the slope-intercept method for other ligands. Stability constants of the metal complexes were evaluated from slope and intercept by least squares treatment. 1:1 and 1:2 complexes were formed for the different systems, and no evidence was found for the existence of polymeric species. (B.L.M.)

38866 LUMINESCENCE SPECTRA OF CRYSTALS OF URANYL FLUORIDE AT 77°K. Komyak, A. I.; Karasev, V. E. Zh. Prikl. Spektrosk.; 12: 323-7(Feb 1970). (In Russian).

The luminescence spectra of crystals of uranyl tetra- and pentafluorides were studied at liquid nitrogen temperature. The splitting of the most intensive lines of the luminescence spectrum was related to the existence of the Davidovich effect in $Cs_2UO_2F_4 \cdot H_2O$ and $Rb_2UO_2F_4 \cdot H_2O$ crystals. The effects of ligands and second cations on the luminescence were studied. From the presence in the spectrum of frequencies due to the complex NH_4^+ ion, the absence of purely ionic reactions between the $(UO_2F_5)^{3-}$ complex and the ammonium ion in the crystal lattice was postulated. Additional proof of this premise is the increase of $(NH_4)_3UO_2F_5$ in comparison with analogous crystals with potassium and rubidium. (tr-auth)

38867 COMBINED SCATTERING SPECTRA OF ANIONIC URANYL COMPLEXES. Bukalov, S. S.; Bdovenko, V. M.; Ladygin, I. N.; Suglobov, D. N. Zh. Prikl. Spektrosk.; 12: 341-4(Feb 1970). (In Russian).

With the utilization of a helium–neon laser as a source of excitation and the photographic recording of the spectrum, the combined scattering spectra of crystalline powders of $K_3UO_2F_5$, $Cs_3UO_2F_4$, $Cs_2UO_2Br_4$, $((C_2H_5)_4N)_2UO_2Br_4$, $KUO_2(NO_3)_3$, $K_4UO_2(CO_3)_3$, and $(NH_4)_4UO_2(CO_3)_3$ were obtained. Frequencies were designated on the basis of comparison with the infrared absorption spectra of the indicated complexes. The manifestation of deformation oscillation of the uranyl group in infrared and combined scattering spectra of uranyl complexes is discussed. (tr-auth)

38868 PRIMENENIE RADIOAKTIVNYKH IZOTOPOV V KHIMICHESKOI KINETIKE (KINETICHESKII IZOTOPNYI METOD). (Application of Radioactive Isotopes in Chemical Kinetics (Kinetic Isotopic Method)). Neiman, M. B.; Gal, D. Moscow; Izdatel'stvo Nauka (1970). 240p.

The theoretical basis for the kinetic isotope method is covered in the first two chapters of the book. The possibility of studying complex chemical reactions under dynamic conditions in an ideally mixing reactor is discussed in the third chapter. The fourth chapter is devoted to a discussion of hydrocarbon cracking reactions. Oxidation of hydrocarbons in the gaseous phase and the problems of radical reaction competition in chemical kinetics are handled in the fifth and sixth chapters. The seventh and eighth chapters are concerned with the problems of liquid-phase oxidation of hydrocarbons and catalytic processes, considering heterogeneous reactions of dehydrogenation and dehydration. The ninth and last chapter deals with the applications of the kinetic isotope method in studies of biochemical methods. References are found at the end of each chapter. (R.V.J.)

38869 INFRARED CHEMILUMINESCENCE FROM THE REACTION OF HYDROGEN ATOMS WITH SCl_2, S_2Cl_2, $SOCl_2$, SO_2Cl_2, AND OCl_2. Perona, M. J.; Setser, D. W.; Johnson, R. J. (Kansas State Univ., Manhattan). J. Chem. Phys.; 52: 6384-90(15 Jun 1970).

The hydrogen chloride infrared emission from the reactions of H atoms with OCl_2, SCl_2, S_2Cl_2, $SOCl_2$, and SO_2Cl_2 was studied under a variety of conditions. A limited number of experiments with the deuterium atom reactions also are reported. The emission from the highest vibrational level gave an estimate of the first sulfur–chlorine bond dissociation energy for these compounds. The emission intensities, relative to H + Cl_2, from the various reactions were measured and were used to estimate relative rate constants, which decline through the series OCl_2, Cl_2, SCl_2, S_2Cl_2, $SOCl_2$, and SO_2Cl_2. Qualitative deductions about the energy partitioned to the HCl product by the different reactions are presented. (auth)

38870 HYDROGEN CHLORIDE VIBRATIONAL POPULATIONS PRODUCED BY THE H AND D ATOM REACTIONS WITH SCl_2 AND S_2Cl_2. Johnson, R. L.; Perona, M. J.; Setser, D. W. (Kansas State Univ., Manhattan). J. Chem. Phys.; 52: 6372-83(15 Jun 1970).

Infrared emission intensities from HCl and DCl products in high vibrational levels were used to measure energy partitioning in the reactions of H and D atoms with SCl_2 and S_2Cl_2. The results are compared to the infrared chemiluminescence from the H and D atom reactions with Cl_2. The relative vibrational level populations were measured under experimental conditions such that vibrational relaxation was minimized. The H atom reactions with SCl_2 and S_2Cl_2 partitioned >37% and >36% of the available energy into vibrational energy of the hydrogen chloride product. Within experimental error the fraction of energy partitioned to vibration was the same for the H and D atom reactions. In the reactions of H and D with SCl_2 and S_2Cl_2 the distribution of rate constants for formation of HCl and DCl into the vibrational levels apparently peaked at levels intermediate between v = 0 and the maximum possible level of vibrational excitation. The distributions were similar to those from the H and D atom reactions with Cl_2. The additional internal degrees of freedom in S_2Cl_2 relative to SCl_2 did not greatly affect the partitioning of energy to the HCl product. (auth)

38871 CRYSTAL STRUCTURES OF THE THREE MODIFICATIONS OF ^{14}N AND ^{15}N AT HIGH PRESSURE. Schuch, A. F.; Mills, R. L. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys.; 52: 6000-8(15 Jun 1970).

It was determined from x-ray diffraction photographs that high-pressure γ N_2 is tetragonal with two molecules per unit cell in special position f of space group $P4_2/mnm$. At an average pressure and temperature of 4015 atm and 20.5°K, respectively, the unit cell dimensions are a = 3.957 Å and c = 5.109 Å, giving a molar volume in good agreement with that from p–V–T measurements. The β N_2 solid modification, which is contiguous with the melting curve, remains hexagonal up to at least 4125 atm and 49°K where the unit cell constants are a = 3.861 Å and c = 6.265 Å. Over the pressure range investigated, the c/a ratio is very close to the ideal value for closest packing of hard spheres. The atomic positions in hexagonal (β) N_2, which are known to be highly disordered at low pressure, show no evidence of ordering at the highest pressures studied. The third allotrope, α N_2, is cubic at 3785 atm and 19.6°K with four molecules in a unit cell 5.433 Å on a side. Both the Pa3 and $P2_13$ space groups, which have been reported at zero pressure, appear to be spatially possible at limiting high pressures for α N_2. However, from diffraction measurements on the cubic solid at all pressures, the existence of $P2_13$ structure could not be proved. The measurements on pure $^{15}N_2$ show that this isotope also exists in the same three solid modifications as $^{29}N_2$ with cell dimensions that are similar for both isotopes. However, the transition to γ N_2 at 20°K for the mass-15 isotope occurs 400 atm lower than that for the mass-14 isotope. (auth)

38872 HYPERFINE STRUCTURE CONSTANTS OF HF AND DF. Muenter, J. S.; Klemperer, William (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 52: 6033-7(15 Jun 1970).

The radio frequency spectrum of HF and DF is measured by the molecular-beam electric resonance method. The measurements are in the lowest vibrational state (v = 0) and first rotational state (J = 1). The constants obtained are:

	HF	DF
μ (D)	1.826526 (7)	1.818805 (5)
C_F (kHz)	307.637 (20)	158.356 (45)
C_H (kHz)	−71.128 (24)	−5.755 (19)
S_{HF} (kHz)	28.675 (5)	4.434 (9)
J_{HF} (kHz)	0.529 (23)	
(eqQ) D		354.238 (78)

The electron coupled spin–spin interaction, J_{HF} = +530 Hz. (auth)

38873 CALCULATION OF ION-MOLECULE REACTION PRODUCT DISTRIBUTIONS USING THE QUASIEQUILIBRIUM THEORY OF MASS SPECTRA. Buttrill, S. E. Jr. (Stanford Univ., Calif.). J. Chem. Phys.; 52: 6174-83(15 Jun 1970).

The quasiequilibrium theory of unimolecular reactions was applied to the calculation of ion-molecule reaction product distributions in ethylene and ethylene–acetylene mixtures. The unimolecular decomposition rates of the ion-molecule reaction complex were computed using the continuous approximation of Vestal et al. [J. Chem. Phys., 37: 1276 (1962)]. The reactions investigated include

$$C_2H_3^+ + CH_2, \qquad C_2H_3^+ + CH_3,$$
$$C_2H_5^+ + C_2H_4 \quad \text{and} \quad C_4H_5^+ \rightarrow$$
$$C_4H_7^+H \qquad C_4H_4^+ + H$$

as well as analogous reactions of the perdeuterated compounds. The calculated and experimental product distributions were in good agreement. When the reaction complex was formed from only partially deuterated reactants, there is an isotope effect favoring

loss of hydrogen over deuterium. The theory accurately predicted this effect. The calculation of isotope effects allows very little freedom in the choice of variables such as activation energy or activated complex configurations. The success of these calculations is therefore strong evidence for the validity of the equilibrium hypothesis. (auth)

38874 DETERMINATION OF BARRIERS TO INTERNAL ROTATION. Ewig, Carl S.; Harris, David O. (Univ. of California, Santa Barbara). J. Chem. Phys.; 52: 6268-71(15 Jun 1970).

A method is presented for determining barriers to internal rotation directly from the spectrum of torsional energy levels without an a priori knowledge of either molecular geometry or the dynamics of the motion. The method is applied to the H_2O_2 and D_2O_2 molecules. It is also shown that the neglect of the variation of the effective inverse moment of inertia of threefold rotors can lead to an apparent V_6 contribution to the potential function. (auth)

38875 VIBRATIONAL SPECTRA AND POTENTIAL FUNCTIONS OF CYCLOHEXANE AND RELATED OXANES. Pickett, Herbert M.; Strauss, Herbert L. (Univ. of California, Berkeley). J. Chem. Phys.; 53: 376-87(1 Jul 197).

The vibrational spectra of cyclohexane, s-trioxane, p-dioxane, m-dioxane, and tetrahydropyran and a number of their deuterated derivatives are re-examined. Particular attention is paid to the low-frequency modes. A number of low-frequency difference bands and some hot bands are observed and assigned. Complete normal-coordinate analyses are carried out for all the molecules. It is concluded that the six ring bending modes contain little contribution from other valence coordinates. A potential function for ring bending is then developed using the vibrational frequencies and the available information on molecular geometries. A onefold term in the torsional part of the potential is found to be necessary. The final potential function gives an excellent fit to the frequencies of the lowest-frequency modes and to the geometries of the molecules considered. This potential function should be useful in conformational analysis. (auth)

38876 PHOTOELECTRON SPECTROSCOPY OF NH_3 AND ND_3 USING MOLECULAR BEAMS. Weiss, M. J.; Lawrence, G. M. (McDonnell-Douglas Corp., Huntington Beach, Calif.). J. Chem. Phys.; 53: 214-18(1 Jul 1970).

Ammonia and ammonia-d_3 were examined with high resolution photoelectron spectroscopy using the 584-Å resonance line of helium. The spectra consist of two electronic states which are formed as a result of severe geometrical changes in the ground state molecule. The onset for the first state, consisting of a vibrational envelope of the ν_2 out of plane banding mode, was at 10.175 ± 0.010 eV in NH_3, 10.180 ± 0.010 eV in ND_3. The second electronic state of NH_3 and ND_3 is complex. Onset was found to be 14.94 ± 0.03 eV for both NH_3 and ND_3. The band in NH_3 apparently consists of two consecutive vibrational series (I and II) having different frequency intervals and are superimposed on a continuum. In ND_3 series I is missing, although series II is present with a spacing consistent with an isotope effect of some unknown vibrational mode. (auth)

38877 ELECTRONIC SPECTRA OF THE $5f^2$ ACTINIDES: U^{3+}, Np^{4+}, Pu^{5+}, AND AmO_2^{++}. THE f^2 INTERMEDIATE COUPLING DIAGRAM. Varga, L. P. (Oklahoma State Univ., Stillwater); Reisfeld, M. J.; Asprey, L. B. J. Chem. Phys.; 53: 250-5 (1 Jul 1970).

The absorption spectra of fluoride salts of $5f^3$ Np^{4+} obtained at room temperature in various environments were compared with the known spectra of f^3 Nd^{3+} and U^{3+}. Correlation with known spectra allowed assignment of levels to Np^{4+}, and based on these, the complete 41-level f^3 intermediate spin–orbit coupling diagram was constructed. The diagram was used to interpret the absorption spectra and to make spectroscopic assignments to 12 low-lying electronic energy levels for Pu^{5+}. Ten low-lying levels for Am(VI) obtained from published AmO_2^{++} aqueous solution spectra were interpreted also. Spectroscopic parameters obtained from least-squares fits to the observed spectra were: Np^{4+}, $F_2 = 232.4$ cm^{-1}, $\zeta = 2178$ cm^{-1}; Pu^{5+}, $F_2 = 230.5$ cm^{-1}, $\zeta = 2295$ cm^{-1}; AmO_2^{++}, $F_2 = 260.3$ cm^{-1}, $\zeta = 3070$ cm^{-1}. Only the lowest-lying energy levels were found to be in substantial agreement with the f^3 intermediate coupling diagram. (auth)

38878 RAMAN SPECTRA OF MoF_6, TcF_6, ReF_6, UF_6, SF_6, SeF_6, AND TeF_6 IN THE VAPOR STATE. Claassen, Howard H.; Goodman, Gordon L.; Holloway, John H.; Selig, Henry (Argonne National Lab., Ill.). J. Chem. Phys.; 53: 341-8(1 Jul 1970).

Raman spectra of MoF_6, TcF_6, ReF_6, UF_6, SF_6, SeF_6, and TeF_6 were observed for the gaseous state using laser excitation. Some assignments of fundamental frequencies have to be revised from previously accepted values. The overtone $2\nu_6$ was observed for all these gaseous hexafluorides and several other overtones were observed for some of the molecules. Considerable broadening of the e_g and f_{2g} fundamentals were observed for TcF_6 and for ReF_6. This broadening is attributed to dynamic Jahn–Teller coupling. The best currently available measured values of fundamental frequencies for all 15 hexafluoride molecules of known O_h symmetry are tabulated. (auth)

38879 SIMPLEST CHEMICAL REACTIONS: EXCHANGE IN THE H_3^+ SYSTEM. Krenos, John; Wolfgang, Richard (Yale Univ., New Haven). J. Chem. Phys.; 52: 5961-2(1 Jun 1970).

The hydrogen atom exchanges of the type $H^+ + H_2 \rightarrow H_2 + H^+$, or $H_2^+ + H$ are the simplest chemical reactions. The existence of these simple reactions in at least seven isotopic variations was established and preliminary data on some of the mechanisms involved were obtained. Relative yields as a function of collision energy for forward-directed products are given. Reactions in which the atomic ions are produced are almost thermoneutral and exhibit yields that drop rapidly with increasing collision energy. Production of molecular ions, H_2^+, is approximately 1.85 eV endoergic. (D.H.M.)

38880 PARTIAL MOLAL HEAT CAPACITY AT INFINITE DILUTION OF AMINO ACIDS IN H_2O AND D_2O SOLUTIONS AT 25^0. Kresheck, Gordon C. (Northern Illinois Univ., DeKalb). J. Chem. Phys.; 52: 5966-7(1 Jun 1970).

The partial molal heat capacities at infinite dilution of methionine, glycine, and norvaline in H_2O and D_2O and for glycine and methionine in ethanol, urea, potassium iodide, and sodium chloride are presented. The observed difference in heat capacity in H_2O between methionine and glycine and between norvaline and glycine give rise to values for the nonpolar side chains of 76 cal/mole-deg. (D.H.M.)

38881 STRUCTURAL STUDIES OF MONOCATIONS OF SPARTEINE AND ITS STEREOISOMERS BY INFRARED SPECTROSCOPY. Skolik, J.; Wiewiorowski, M. (Univ., Poznan, Poland). J. Mol. Struct.; 5: 461-76(Jun 1970).

The location of the acidic proton and the skeletal conformations of sparteine, α-isosparteine, and β-isosparteine monoperchlorates were investigated by means of infrared spectroscopy in the 2840 to 2600 cm^{-1} and 2400 to 2000 cm^{-1} regions. Spectra were compared with those of selected deuterated derivatives. (J.G.B.)

38882 THE CHARACTER OF LOW FREQUENCY (250–40 cm^{-1}) RAMAN BANDS FROM ORGANIC LIQUIDS AND THEIR COMPARISON TO FAR INFRARED ABSORPTION. McDevitt, Neil T. (Air Force Materials Lab., Wright-Patterson AFB, Ohio); Fateley, W. G. J. Mol. Struct.; 5: 477-91(Jun 1970).

The low frequency Raman scattering of 28 aromatic compounds were measured in the liquid phase. Low frequency ir spectra of benzene and deuterated benzene were recorded. There was found to be no correlation between the Raman scattering and the observed low frequency infrared absorption found in these liquids. Attempts to relate the Raman scattering to mass effects and dipole moments failed to show any apparent correlation. The Raman scattering and infrared absorption are interpreted as arising from the formation of a transient complex between two or more molecules. The Raman scattering arises from the symmetrical vibration or translational libration of the complex, while the low frequency infrared absorption is the direct consequence of a hindered rotational vibration of the molecule, in this case, the benzene ring in the complex. (auth)

38883 THORIUM NITRIDE HALOGENIDES. Juza, Robert; Sievers, Rolf (Christian-Albrechts-Univ., Kiel). Z. Anorg. Allg. Chem.; 363: 258-72(Dec 1968). (In German).

ThNF was prepared by ammonolysis of ThF_4 in a current of ammonia at 850°C. The compound is resistant against moisture, it crystallizes in rhombohedral layer type lattice, isotypic with LaOF. ThNF can also be prepared from Th_3N_4 and ThF_4. This reaction also yields two further phases ThN_xF_{4-3x}. The phase with $0.94 \geq x \geq 0.88$ is tetragonal, whereas the other one with $0.87 \geq x \geq 0.79$ is orthorhombic. The same methods yielded the compounds ThNCl, ThNBr, ThNI at 650°C. The sensitivity against moisture increases in the same order. They crystallize isotypic with BiOCl. (auth)

38884 HETEROGENEOUS ISOTOPIC EXCHANGE AT THE INTERFACE OF STEEL SHEETS IN CONTACT WITH IRON CHLORIDE SOLUTION. I. QUALIFICATION AND PREPARATION OF THE METAL SURFACE. Farkas, J.; Nagy, L. G.; Varsanyi, G. (Technical Univ., Budapest). Period. Polytech. Chem. Eng.; 13: No. 3, 267-79(1969).

The surfaces of steel plates used for the investigation into heterogeneous isotope exchange processes were prepared. Sur-

face purity and the increase in surface area due to surface roughness were determined. Methods for preparing the surface and control tests of the surface are presented. (J.G.B.)

38885 PREPARATION OF CUBIC CHLORO COMPLEX COMPOUNDS OF TRIVALENT METALS: Cs_2NaMCl_6. Morss, L. R.; Siegal, M.; Stenger, L.; Edelstein, N. (Univ. of California, Berkeley). Inorg. Chem.; 9: 1771-5(Jul 1970).

Compounds of the empirical formula Cs_2NaMCl_6 have been prepared for a large number of trivalent cations. In each compound the trivalent cation is surrounded octahedrally by 6 chlorides. Lattice parameters and elemental analyses are presented for 22 different compounds. (B.L.M.)

38886 BAND SPECTRA AND HYPERFINE STRUCTURE OF HgH, HgD, AND HgT. Eakin, David M.; Davis, Sumner P. (Univ. of California, Berkeley). J. Mol. Spectrosc.; 35: 27-42(Jul 1970).

The analysis of the band spectrum ($A_1\ ^2\Pi_{\frac{1}{2}} - X^2\Sigma^+$ system) of HgH was extended to include $v'' = 4$, and that of HgD to include $v'' = 5$. Rotational constants for these levels were calculated. The HgT molecular spectrum was produced, partially analyzed, and some constants were calculated. Spin splitting in the ground state of all three molecules is discussed and vibrational energy levels are compared. Magnetic hyperfine structure in the band spectra of ^{199}HgD and ^{199}HgT was observed and analyzed. Measurements are presented and the analysis is compared with theory. (auth)

38887 ZIRCONATES, HAFNATES, AND THORATES OF BARIUM, STRONTIUM, LITHIUM, AND SODIUM. Scholder, R.; Raede, D.; Schwarz, H. (Univ., Karlsruhe, Ger.). Z. Anorg. Allg. Chem.; 362: 149-68(Oct 1968). (In German).

In the systems $M(II)O-X(IV)O_2$ with M(II) = Sr, Ba; X(IV) = Zr, Hf besides meta compounds more basic compounds of the type $M(II)X(IV)O_4$, having the tetragonal K_2NiF_4 structure, exist. Investigations on the systems $Li_2O-X(IV)O_2$ (X(IV) = Zr, Hf) resulted in the preparation and characterization of the new compound types $Li_4X(IV)O_4$ and $Li_8X(IV)O_6$. ThO_2 gives with alkaline earth and alkali metal oxides only meta compounds, however, no reaction with Li_2O. A close structural relation between Na_2ThO_3 and Li_2ZrO_3 exists according to their x-ray powder diagrams. (auth)

38888 INFLUENCE OF ISOTOPY ON THE PHYSICOCHEMICAL PROPERTIES OF LIQUIDS. Rabinovich, Izrail B. New York; Plenum Publishing Corp. (1970). 312p. $35.00. (NP-tr-1913).

Translation of Vliyanie Izotopii na Fiziko-Khimicheskie Svoistva Zhidkostei.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 21690.

38889 EVIDENCE FOR AN ISOTOPE EFFECT ON ELECTRON DRIFT MOBILITIES IN ANTHRACENE CRYSTALS. Munn, R. W.; Nicholson, J. R.; Siebrand, W.; Williams, D. F. (National Research Council of Canada, Ottawa). J. Chem. Phys.; 52: 6442-3(15 Jun 1970).

A comparative measurement was made of the electron drift mobility along the C′ direction in single crystals of $C_{14}H_{10}$ and $C_{14}D_{10}$. On the average, trapping was stronger for $C_{14}D_{10}$ than for $C_{14}H_{10}$. The observed mobilities and their standard deviations were (in $cm^2/v \cdot sec$): 0.342 ± 0.034 for $C_{14}H_{10}$ and 0.378 ± 0.030 for $C_{14}D_{10}$. (M.C.G.)

38890 LUMINESCENCE OF BIPHENYL AND GEOMETRY OF THE MOLECULE IN EXCITED ELECTRONIC STATES. Lim, E. C.; Li, Y. H. (Wayne State Univ., Detroit). J. Chem. Phys.; 52: 6416-22(15 Jun 1970).

Fluorescence and phosphorescence spectra of biphenyl, biphenyl-d_{10}, and related compounds were studied in n-heptane at 77°K. The fluorescence spectrum of each of these compounds displays a long progression involving odd quanta of a low-frequency vibration, while the phosphorescence spectrum exhibits a short progression involving even quanta of the same vibrational mode. The fundamental frequencies in these progressions are 635 cm^{-1} for biphenyl, 595 cm^{-1} for biphenyl-d_{10}, and 626 cm^{-1} for 4, 4′-difluorobiphenyl. From their appearance in Raman spectra (but not in infrared), the ratio of the frequencies in the isotopic species, their dependence on the position of substitutions, and their absence in the fluorescence spectrum of crystalline biphenyl, these frequencies are concluded to be the torsional frequencies in the ground state. The prominence of odd quanta of the torsional mode in fluorescence and even quanta in phosphorescence is shown to be a strong indication that the molecule of biphenyl is planar in the lowest excited states (singlet and triplet). (auth)

38891 FORMATION AND CHARACTERIZATION OF DIVALENT EINSTEINIUM IN A CaF_2 CRYSTAL. Edelstein, N.; Conway, John G.; Fujita, D.; Kolbe, W.; McLaughlin, R. (Univ. of California, Berkeley). J. Chem. Phys.; 52: 6425-6(15 Jun 1970).

The identification by EPR of Es^{2+} in CaF_2 is reported. $^{253}Es^{3+}$ was mixed with powered CaF_2 and the mixture coalesced. The crystal that formed was radioluminescent and reddish. Results showed that dispositive Es is more readily stabilized in CaF_2 than the earlier actinides. (M.C.G.)

38892 α DEPENDENCE OF THE VIBRATIONAL ZERO-POINT ENERGY IN THE PARTIALLY DEUTERATED METHYL ALCOHOLS. Walker, Gary L.; Quade, C. R. (Texas Tech. Univ., Lubbock). J. Chem. Phys.; 52: 6427-8(15 Jun 1970).

The α dependence of the vibrational zero-point energy for CH_2DOH and CHD_2OH was calculated, where α is the angle of relative orientation between the internal rotor and the rest of the molecule. (M.C.G.)

38893 ELECTRICAL CONDUCTIVITY IN NH_4Cl AND ND_4Cl SINGLE CRYSTALS. Fuller, R. G.; Patten, F. W. (Naval Research Lab., Washington, D. C.). J. Phys. Chem. Solids; 31: 1539-45(Jul 1970).

Electric conductivity measurements are reported for normal and deuterated ammonium chloride single crystals in the temperature regions that characterize the pure and the impurity-dominated materials. It was concluded from the data that conductivity in ammonium chloride is due to the formation of either cation or anion vacancies and a subsequent process controlled by a proton transfer. The results were found to be consistent with a model proposed by Herrington and Staveley (1964). (auth) (UK)

38894 INFRARED INVESTIGATION OF STRUCTURAL AND ORDERING CHANGES IN AMMONIUM CHLORIDE AND BROMIDE. Schumaker, Norman E.; Garland, Carl W. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys.; 53: 392-407(1 Jul 1970).

Infrared spectra of NH_4Cl, ND_4Cl, NH_4Br, and ND_4Br were recorded at numerous temperatures between 21 and 300°K using thin sublimed films, single-crystal sections, and pressed disks. At 21°K each spectrum contains a large number of sharp intense bands which can be assigned to combinations involving the internal vibrational modes of the ammonium ion, the librational (torsional oscillation) mode, and various lattice modes. Observation of the first and second librational overtone makes it possible to discuss the potential barrier hindering the rotation of the ammonium ion. Barrier heights of 1860 cm^{-1} (5.32 kcal $mole^{-1}$) for NH_4Cl and ND_4Cl and 1520 cm^{-1} (4.35 kcal $mole^{-1}$) for NH_4Br and ND_4Br were calculated from the Gutowsky–Pake–Bersohn model, but the experimental frequencies show that the libration is more anharmonic than this model would predict. The temperature dependence of an anomalous component of the ν_4 bending fundamental was studied in detail. The intensity of this component can be directly correlated with the breakdown of translation symmetry due to disorder in the ammonium ion orientations. In addition, this feature of the spectrum indicates that there is appreciable distortion in the ordered cubic phase of NH_4Br and ND_4Br prior to the first-order transition into the ordered tetragonal phase. (auth)

38895 CHEMISTRY OF PROMETHIUM. Weigel, F. (Univ., Munich). Fortschr. Chem. Forsch.; 12: 539-621(1969). (In German).

Topics covered include: nuclear properties, preparation and isolation of promethium, metallic promethium, spectrochemistry, chemical properties, uses, and protective methods in work with promethium. (198 references). (M.C.G.)

38896 FAR-INFRARED AND RAMAN SPECTRA OF PHOSPHONIUM CHLORIDE AND PHOSPHONIUM CHLORIDE-d_4. Durig, J. R.; Antion, D. J.; Pate, C. B. (Univ. of South Carolina, Columbia). J. Chem. Phys.; 52: 5542-8(1 Jun 1970).

The far-infrared spectra of thin films of PH_4Cl and PD_4Cl have been recorded at −170°C. Raman spectra of polycrystalline samples of both compounds were also recorded at −170°C. One libration and three translations were observed as well as eight internal modes. Several combinations and overtones were assigned and the zone-edge wavenumber of a second libration has been inferred. The barrier restricting reorientation of the PH_4 and PD_4 ions has been calculated from the observed librational wavenumbers to be 8.5 kcal/mole and forces contributing to the barrier are discussed. The lattice dimensions of PH_4Cl were determined to be $a = b = 5.62$ Å and $c = 4.22$ Å from the x-ray diffraction pattern of a polycrystalline sample. (auth)

Radiation and Nuclear Chemistry

Refer also to abstracts 38770, 38986, 39432, 39730, and 40577.

38897 (AAEC/TM-537) EFFECT OF HIGH TEMPERATURES ON THE RADIATION CHEMISTRY OF AQUEOUS SOLUTIONS. A Literature Survey. Matthews, R. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr 1970. 16p. Dep. CFSTI (U. S. Sales Only).

The literature dealing with the radiation chemistry of aqueous solutions at high temperatures is surveyed in order to evaluate significant differences from ambient temperature radiation chemistry. Particular attention is paid to the effect of these differences on water radiolysis in nuclear reactors. References are complete to the end of 1968 and some 1969 ones are also included. A number of experimental studies are suggested for future research. (auth) (Australia)

38898 (IS-T-366) REACTIONS OF ^{11}C IN AROMATIC AND OXYGEN-CONTAINING ORGANIC COMPOUNDS. Williams, Ronald Lloyde (Ames Lab., Iowa). May 1970. Contract W-7405-eng-82. 141p. Dep. CFSTI.

Thesis.

Carbon-11 was produced by the reaction $^{12}C(\gamma,n)^{11}C$ in several liquid organic compounds and the labeled products were analyzed by radiogas chromatography. A wide variety of products from methane to phenylacetylene was observed in benzene, toluene, and p-xylene accounting for 20 to 35% of the total ^{11}C activity in these systems. The production of analogous products in these systems was discussed, and the effect of the methyl groups on the product distribution was evaluated. The remainder of the activity was shown to reside in higher boiling compounds. The yields of C_1 and C_2 products from a variety of simple alcohols and ethers were determined in the pure systems and in the presence of iodine as a scavenging agent. It was shown that the ^{11}CO yields in the scavenged systems can be correlated with a simple bond site model based on the structure of these compounds. The relative reactivity of the molecules toward deoxygenation by atomic carbon depends strongly on electronic factors which alter the availability of nonbonding electron pairs on the oxygen atom. The reaction pathways available to the intermediate produced by carbon atom insertion into the C–H bonds of methanol were examined in an analysis using product yields determined in radiation dose and radical scavenging experiments. It was proposed that this intermediate is the precursor of methyl acetate and acetaldehyde. The ability of iodine and bromine to trap intermediates in the proposed reaction sequence apparently results in the replacement of these products by methyliodoacetate and 2-iododimethoxyethane. The conversion of acetaldehyde to the acetal in methanol–iodine solutions was suggested as an explanation of the dimethoxyethane observed in the scavenged recoil system. The dependence of carbon monoxide, acetaldehyde, and glycolaldehyde yields on irradiation time was attributed to reactions of the solvated electron in methanol. Relative reaction rates were determined on the basis of a proposed reaction sequence. (auth)

38899 (PRNC-135, pp 156-7) COMBINED RADIATION AND CHEMICAL CATALYST SYSTEM FOR IMPROVING POLYMERIZATION RATES. Colombo, P.; Gabarain, R. V. A.; Fontana, J.; Steinberg, M. (Brookhaven National Lab., Upton, N. Y.).

From Radiation and isotope technology in Latin American development.

In attempting to increase radiation polymerization rates without increasing radiation intensity, a new technique is being developed. This technique involves the addition of a chemical catalyst to the monomer prior to irradiation. The initial work is being conducted with styrene monomer, benzoyl peroxide, and ^{60}Co radiation sources. Styrene monomer was selected because it requires a high radiation dose for polymerization. The monomer was used as received from the manufacturer, containing 25 ppM tert-butylpyrocatechol. The experimental results obtained to date are reviewed. (P.C.H.)

38900 RADIOLYSIS OF AQUEOUS SOLUTIONS OF RUTHENIUM(III) HEXA-AMMINE CHLOROPENTA-AMMINE. Baxendale, J. H.; Rodgers, M. A. J.; Ward, M. D. (Univ. of Manchester, Eng.). J. Chem. Soc., A; No. 8, 1246-50(1970).

$Ru(NH_3)_6^{3+}$ is reduced by e^-_{aq} and by the radical CH_2OH to $Ru(NH_3)_6^{2+}$. Similar reduction of $Ru(NH_3)_5Cl^{2+}$ first gives $Ru(NH_3)_5Cl^+$ which aquates to $Ru(NH_3)_5H_2O^{3+}$ with rate constant of 4.7 sec^{-1}. The aquo-ion reduces the original $Ru(NH_3)_5Cl^{2+}$ to give $Ru(NH_3)_5Cl^+$ and $Ru(NH_3)_5H_2O^{2+}$ with a rate constant 1.0×10^9 l $mole^{-1}$ sec^{-1} so that the aquation of $Ru(NH_3)_5Cl^{2+}$ is catalyzed by small amounts of the reduced species. Oxidation of $Ru(NH_3)_6^{2+}$ by OH appears to give $Ru(NH_3)_6^{+}$ as the primary product, which decays by a bimolecular process ($k = 4.5 \times 10^9$ l $mole^{-1}$ sec^{-1}) to give species tentatively designed as $Ru(NH_3)_6^{+}$ and $Ru(NH_3)_6^{-}$. The former has a half-life of 0.75 sec and leads to products which decay slowly during hours. Oxidation of $Ru(NH_3)_5Cl^{2+}$ differs in that there are three compounds formed successively in first-order processes after the primary oxidation step, with rate constants 2.5×10^3, 44, and 0.45 sec^{-1}. It is suggested that these are aquation products formed from $Ru(NH_3)_5Cl^{2+}$. Absorption spectra of the intermediates have been obtained. (auth) (UK)

38901 PARAMAGNETIC RELAXATION OF MACRORADICALS STABILIZED IN γ-IRRADIATED POLYCAPROLACTAM. Taranukha, O. M.; Vonsyatskii, V. A.; Lebedev, Ya. S. (Inst. of High-Molecular Compounds, Kiev. Inst. of Chemical Physics, Moscow). Teor. Eksp. Khim.; 6: 235-42 (Mar-Apr 1970). (In Russian).

Studies of microwave saturation of EPR signals in γ-irradiated polycaprolactam showed that the expansion is a function of the irradiation dose. An increase in the dose from 6 to 500 MRAD changes the character of the expansion from nonhomogeneous to homogeneous which cannot be explained within the limits of the concepts of noninteracting spin or packages. The theory of chaotic diffusion was used for describing the obtained data and for calculating the basic paramagnetic relation parameters of macroradicals. The relation of the spectral diffusion rate and spin-lattice relaxation time was studied in specimens irradiated with 200 MRAD doses. The time of spin-lattice relaxation was in inverse proportion to the temperature quadrature which corresponds to the two-phonon mechanism of relaxation. (tr-auth)

38902 CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS. Maddock, A. G. (Cambridge Univ., Eng.). Chem. Brit.; 6: 287-92(Jul 1970).

Past work is reviewed and discussed. Hot reactions in the gases T, ^{18}F, and ^{11}C are considered and the recoil and ionisation processes involved compared with liquid systems where the cage effect exists. The effect increases in solid systems which makes hot reactions difficult to demonstrate and interest here is the identity and environment of the fragments produced in individual nuclear events and the characteristics of the annealing reactions. These reactions and their study by observation of photon emission and the use of angular correlation measurements are discussed. The direction of future research into the production of hot atoms and nuclear transformations in solids is indicated. (UK)

38903 RADIATION-INDUCED SOLUTION POLYMERIZATION OF STYRENE IN AN ENGINEERING FLOW SYSTEM. Osborne, F. T.; Omi, S.; Stannett, V.; Stahel, E. P. (North Carolina State Univ., Raleigh). J. Polym. Sci., Part A-1; 8: 1657-74(Jul 1970).

Radioinduced solution polymerization of styrene in methylene chloride in a small scale pilot plant utilizing a flow reactor is reported. Both conventional free radical and ionic polymerization were achieved. With rigorous drying accomplished over molecular sieves the ionic mechanism predominates. Conclusive kinetic evidence as well as polymer properties substantiate radiation induced ionic polymerization for the first time in an engineering pilot plant. The validity of Williams' model is reinforced by this study and a survey of over 100 literature observations. (auth)

38904 ELECTRON SPIN RESONANCE STUDIES ON GRAFT COPOLYMERIZATION OF GASEOUS STYRENE ONTO PRE-IRRADIATED POLYPROPYLENE. I. PREIRRADIATION IN THE PRESENCE OF OXYGEN. Eda, Bunzo; Nunome, Keichi; Iwasaki, Machio (Government Industrial Research Inst., Nagoya, Japan). J. Polym. Sci., Part A-1; 8: 1831-40(Jul 1970).

Graft copolymerization of gaseous styrene was carried out onto polypropylene preirradiated in the presence of O at −78°C and at room temperature, respectively. The origin of the graft initiation activities of these polymers was investigated by means of electron spin resonance (ESR) of trapped radicals. More grafting was found for the polymers irradiated at −78°C than for those irradiated at room temperature. The difference of grafting between polymers irradiated at −78°C and those irradiated at room temperature was not explained by the total amounts of trapped radicals, and it was found that all radicals are not effective in the grafting reaction. ESR measurements showed that there exist two kinds of peroxy radicals, one has more effective ability of abstracting hydrogen atoms from the surrounding polymer chains to form carbon radicals, and another is less effective at the temperature of grafting reaction (40°C). Although the samples irradiated at −78°C contain both types of radicals, those irradiated at room temperature do not contain the former type of radicals. It was shown that the carbon radicals produced by such a hydrogen abstraction reaction are actually the effective centers in the grafting reaction of polymers irradiated in the presence of oxygen. (auth)

38905 INFLUENCE OF REACTION CONDITIONS AND SOME SOLUTES ON THE RADIATION-INDUCED ADDITION OF 2-PROPANOL TO MALEIC ACID. Kucera, J. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun.; 35: 1335-48(May 1970).

Irradiation of a solution of maleic acid in 2-propanol by ^{60}Co γ radiation with a dose of 1 to 10×10^{20} eV/ml resulted in terebic acid (lactone of 3-carboxy-4-hydroxy-4-methylvaleric acid) in a

chemical yield of up to 76% and radiation yield of G = 17.4. In addition to this main product, diaterebic acid (nonlactonized form of terebic acid) was obtained in a radiation yield of G = 5.1. In amounts lower by an order of magnitude fumaric, succinic, methylsuccinic, ethylsuccinic, isopropylsuccinic and 1,2,3,4-cyclobutanetetracarboxylic acids were also obtained. An addition of benzophenone or of ammonia suppresses only partly the formation of terebic acid while an addition of tetrabromomethane or of hydrogen bromide slightly increases its yield and suppresses fully the formation of diaterebic acid. It can be concluded that, in contrast with a photoaddition, the radiation addition represents a chain reaction with 3 to 6 transfers. The reaction proceeds probably by two different mechanisms, one of them radical, the other, prevalent, ionic. (auth)

38906 INFLUENCE OF LET ON THE RADIATION YIELD OF FREE IONS IN BENZENE AS MEASURED BY TRITIUM SUBSTITUTION. Kroh, J.; Burzynska, E. (Technical Univ., Lodz, Poland). Radiochem. Radioanal. Lett.; 4: 119-22(8 Jul 1970).

The effect of LET on the radioinduced tritium substitution in the system $C_6H_6 + CH_3OT$ was investigated. The yield of substitution was markedly reduced when ^{60}Co γ radiation is replaced by ^{210}Po α-particles. It is assumed that radiation yield of free ion pairs ($C_6H_6^+ + e^-$) responsible for substitution is reduced in the case of high LET radiation. (auth)

38907 INVESTIGATIONS ON THE MECHANISMS OF ETHYLBENZENE RADIOLYSIS. Hofer, H.; Heusinger, H. (Technische Hochschule, Munich). Z. Phys. Chem. (Frankfurt); 69: 47-66 (Apr 1970). (In German).

Studies were made on the excited or ionized states and hot mechanisms in the radiolytic product formation of ethylbenzene. Radiolysis was compared with photolysis. Hydrogen (G = 0.180), methane (G = 0.026), styrene (G = 0.031), polymer (G = 1.52), and dimers were determined quantitatively. Among the possible side chain dimers—1,3-diphenylbutane (G = 0.0002), 1,4-diphenylbutane (G = 0.0001), and 2,3-diphenylbutane (G = 0.046)—the latter predominates. In order to clarify the mechanism, scavengers for radicals and electrons as well as quenchers for excited states were used. From these investigations it can be deduced that in radiolysis hydrogen and styrene are formed independently from 2,3-diphenylbutane by a hot mechanism. Radiolytic production of 2,3-diphenylbutane at low doses proceeds by reaction of excited states and ion molecule reactions. At high radiation doses the production of the dimer via excited states is suppressed by the radiolytic formation of a quencher. This quencher, which reaches a stationary concentration at 10 Mrad, could be identified as 1,3-diene. The dependence of 2,3-diphenylbutane formation from the diene production, found experimentally, can be described by a Stern–Volmer kinetics. The constancy of diene concentration for high doses suggests that dienes are only intermediates in polymer formation. (auth)

38908 ISOMERIC TRANSITION ACTIVATED REACTIONS OF ^{82}Br WITH GASEOUS METHYL BROMIDE. Oates, D. W.; Ayres, R. L.; Helton, R. W.; Schwartz, K. S.; Rack, E. P. (Univ. of Nebraska, Lincoln). Radiochem. Radioanal. Lett.; 4: 123-9 (8 Jul 1970). (COO-1617-21).

The influence of additives, pressure, and mode of activation on the (n, γ) and (I. T.)-activated ^{82}Br reactions in CH_3Br systems were determined. The observed organic yields were independent of total system pressure and no isotope effect was observed between the (n, γ) and (I. T.)-activated reactions. The similar decrease in the yields of both the $CH_3{}^{82}Br$ and $CH_2Br^{82}Br$ products with increasing Ar moderator concentration suggests that both are formed via excess kinetic energy processes. (auth)

38909 STUDY OF THE CHEMICAL BEHAVIOUR OF RECOIL ATOMS PRODUCED BY THE $^{115}In/\gamma,\gamma'/^{115m}In$ PROCESS. Yoshihara, K.; Yang, M. H.; Shiokawa, T. (Tohoku Univ, Sendai). Radiochem. Radioanal. Lett.; 4: 143-7(8 Jul 1970).

Recoil energy dependence curves of indium ethylene diaminetetraacetate complexes were studied. The appearance energies and the plateau values of these complexes were compared with one another. The order of the appearance energy is H compound < Na compound ≃ K compound. (auth)

38910 RADIOTHERMOLUMINESCENCE OF POLYETHYLENE FILMS UNDER LOAD. Nikol'skii, V. G.; Sapozhnikov, D. N.; Tochin, V. A. (Inst. of Chemical Physics, Moscow). Vysokomol. Soedin., Ser. B; 12: 19-22(Jan 1970). (In Russian).

The thermoluminescence of γ-irradiated films of polyethylene at high pressure in a uniaxial power field was studied. It was discovered that the form of the radiothermoluminescence depends substantially on the load. It is also shown that the radiothermoluminescence method can be used for investigation of induced viscoelasticity. The curve maximum was connected to the transition of the polyethylene in the friable state. (tr-auth)

38911 HOT ATOM CHEMISTRY OF COPPER PHTHALOCYANINE BY THE /n,2n/ REACTION. Sakanoue, M.; Endo, K. (Kanazawa Univ., Japan). Radiochem. Radioanal. Lett.; 4: 99-106(8 Jul 1970).

Chemical effects of the $^{65}Cu(n, 2n)^{64}Cu$ reaction were studied in α- and β-copper phthalocyanines. Irradiation was carried out at room temperature for the α-form and at dry-ice temperature for the β-form. The results were compared with those of the $^{63}Cu(n,\gamma)$ and $^{65}Cu(\gamma,n)$ reactions reported by other authors. It was also found that purification of the sample affected the retention values. (auth)

38912 MATRIX ISOLATION OF THYMINE RADICALS IN γ-IRRADIATED ALKALINE ICE MATRICES. Nazhat, N. B.; Weiss, J. J. (Univ. of Newcastle upon Tyne, Eng.). Trans. Faraday Soc.; 66: 1302-8(Jun 1970)

ESR techniques were used to study the reactions of thymine, thymidine, and dihydrothymine with electrons and O^- radical ions which are produced in the γ-irradiation of frozen aqueous solutions of sodium hydroxide. Electrons can attack thymine at the 5,6 double bond when after proton transfer the thymine radical is produced and an eight-line ESR spectrum is observed. After annealing at temperatures above 77°K the O^- radical ion can react with the methyl group at the 5 position. In thymidine the eight-line ESR spectrum is observed already at 77°K and this increases further in intensity on annealing. The O^- presumably reacts with the methyl group of dihydrothymine. (auth) (UK)

38913 ANNEALING KINETICS OF FREE RADICALS IN IRRADIATED ORGANIC CRYSTALS. Cutten, D. R.; Ericson, L. G. (Univ. of Adelaide). Mol. Cryst. Liquid Cryst.; 6: 351-75(Feb 1970).

Experiments are reported on the production, and annealing kinetics of free radicals in irradiated organic crystals. Both processes are shown to be well reproducible for nominally identical crystals although the annealing rate may be much slower in crystals damaged by previous irradiation and annealing. Free radical destruction was found in numerous instances to proceed by second-order kinetics, the only exception being crystals of acetylglycine where the reaction is third-order. Activation energies of the reactions are reported together with experimental investigation of the deuterium isotope effect. The significance of these results is discussed in relation to the existence of hydrogen atom jumping or "kenon diffusion" as an annealing mechanism. (auth)

38914 RADIOCHEMICAL POLYMERIZATION OF ACRYLIC ACID IN LIQUID AND SOLID PHASE. I. KINETICS. Chapiro, A.; Sommerlatte, T. (CNRS, Bellevue, France). Eur. Polym. J.; 5: 707-24(1969). (In French).

The polymerization kinetics of liquid acrylic acid were complicated by the precipitation of the polymer. The conversion curves initially exhibited an auto-accelerating portion which was followed by an almost straight line. The pseudo-stationary rate was proportional to $I^{0.5}$ and the overall activation energy was 2.7 kcal/mole. The reaction was followed by a significant post-polymerization. Irradiation of the crystalline monomer led to auto-accelerating conversion curves with a parabolic shape. The instantaneous rate was proportional to $I^{0.5 \text{ to } 0.6}$; the overall activation energy was 15.1 kcal/mole. A very short postpolymerization was noticed. Various additives such as water, acetic acid, and cyclohexane increased the polymerization rate at 1°, whereas benzoquinone and acetone inhibited the reaction. If the monomer was carefully dried prior to irradiation, the rate of polymerization in the crystalline state was strongly reduced. A spontaneous polymerization of acrylic acid was noticed during degassing of very dry monomer. An ESR study conclusively demonstrated, in conflict with earlier literature data, that free radicals were trapped in the irradiated crystalline monomer at temperatures where polymerization occurred. (auth)

38915 DIELECTRIC PROPERTIES OF POLY(TETRAFLUOROETHYLENE) ON IRRADIATION WITH ^{60}Co γ RAYS AND FAST ELECTRONS. Matveev, V. K.; Vaisberg, S. E.; Karpov, V. L. (Inst. of Chemical Physics, Moscow). Vysokomol. Soedin., Ser. B; 12: 31-5(Jan 1970). (In Russian).

It was confirmed that a sharp increase in dielectric losses in poly(tetrafluoroethylene) on irradiation in air (or in vacuum without previous degassing of the forms) is caused by the formation of peroxide radicals. It is shown that on irradiation in air at a dose rate of 250 rads/sec, the increase in the tangent of the angle of dielectric losses in poly(tetrafluoroethylene) is not limited by the rate of diffusion of oxygen, while at a dose rate of 7.3×10^4 rads/sec such limitation occurs. The contribution of the two forms of peroxide

radicals (end and intrachain) to the increase in dielectric losses is shown. (tr-auth)

38916 SEPARATION OF CYCLOTRON-PRODUCED ^{111}In FROM A SILVER MATRIX. Neirinckx, R. D. (National Physical Research Lab., Pretoria). Radiochem. Radioanal. Lett.; 4: 153-5 (8 Jul 1970).

A rapid and very efficient method for the separation of carrier-free quantities of indium from the silver matrix is described. The ^{111}In was produced by α-bombardment of natural silver in the variable energy cyclotron of the Council for Scientific and Industrial Research. The procedure is based on a dissolution of the silver target in hot concentrated nitric acid, and subsequent scavenging of the indium with iron hydroxide. (auth)

38917 POST-RECOIL NNEALING AND SOLID-STATE THERMAL EXCHANGE IN TRIS-o-PHENANTHROLINE Co(III) PERCHLORATE. Vaish, S. P. (Univ. of Arizona, Tucson). J. Inorg. Nucl. Chem.; 32: 2082-4(Jun 1970).

It had been previously reported that thermal annealing of neutron irradiated trisdipyridyl Co(III) perchlorate and thermal exchange of the radio-cobalt doped complex follow similar trends. It was also shown, for the same complex, that the presence of water of hydration in the crystals and prior thermal treatment increased the rate of annealing. The studies indicated that electron traps (potential electron donors) present due to crystal imperfections greatly influence the annealing of recoil damage and thermal exchange. Similar studies on tris-o-phenanthroline Co(III) perchlorate are reported and the observations support the view that both thermal annealing of recoil damage and thermal exchange in the doped compound are induced by free electrons. Irradiation was in the thermal column of the CIRUS reactor (Trombay, India) at dry ice temperature. For the exchange studies $^{58}CoCl_2$ was employed for doping purposes. Results for the thermal annealing of the neutron irradiated substance and for the thermal exchange of the doped complex are presented in tubular form. The rate of exchange was much faster than the rate for annealing, but the general behaviour for isotopic thermal exchange and thermal annealing were analogous. The dihydrate complex annealed, or exchanged, faster than the anhydrous compound, and for the neutron irradiated substance dehydration took place at higher temperatures, concurrently with annealing. At all temperatures the dihydrate showed higher retention than the anhydrous substance. Prior thermal treatment of the anhydrous compound increased both the rate of annealing and the rate of thermal exchange during hydration. The results are interpreted on the basis of the variable depth electron donor isotopic exchange model proposed by Nath et al. (Indian Journ. Chem. 4: 51(1966)). (UK)

38918 WOOD-PLASTIC COMBINATION PRODUCED BY γ-IRRADIATION. II. Fukumoto, Tsugio; Akagi, Ryuichi; Tsurugi, Jitsuo. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 71-5(1969).

Radioinduced polymerization of three monomers (methyl methacrylate, styrene, and vinyl acetate) impregnated in persimmon by three methods was studied. Several WPC specimens produced were used to manufacture shuttles. The irradiated specimens impregnated with vinyl acetate by vacuum-pressure method were found to be satisfactorily available for producing shuttles. (auth)

38919 RADIATION POLYMERIZATION OF DIOCTYLVINYLPHOSPHINE OXIDE. Chikishev, Yu. G.; Snimshchikova, A. A.; Tsetlin, B. L. (Inst. of Elemental-Organic Compounds, Moscow). Vysokomol. Soedin., Ser. B; 12: 149-50(Feb 1970). (In Russian).

As a result of the application of the radiation-chemical method of initiation, the polymer form of dioctylvinylphosphine oxide was obtained. The graft polymerization of this monomer was effected from the gas phase. (tr-auth)

38920 EFFECT OF X RADIATION ON RATE OF DIFFUSION OF POLYISOPRENE IN RUBBER. Vladimirskii, Yu. B.; Zakharov, G. M.; Rylov, S. A. (Leningrad Polytechnic Inst.). Vysokomol. Soedin., Ser. B; 12: 165-6(Feb 1970). (In Russian).

It was established that on irradiation of the polymer in an inert medium (argon), the coefficient of diffusion decreased with increasing dose. On irradiation in the presence of oxygen, an increase in the mobility of the macromolecules was first observed, up to a dose of 7×10^5 rads. At larger doses the coefficient of diffusion decreased. This indicates the presence of two competing processes (destruction and joining) on irradiation in an oxidizing atmosphere. It was concluded that oxygen stimulates the process of destruction. The radiation effects on rubber depend on absorption of the dose, the gas medium, and the degree of initial polymerization. (tr-auth)

38921 UNSTABLE INTERMEDIATE. PART LXXI. ELECTRON SPIN RESONANCE SPECTRA OF γ-IRRADIATED TRIMETHYL PHOSPHATE. Begum, A.; Subramanian, S.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 8, 1334-6(1970).

Radiolysis of frozen trimethyl phosphate at 77°K by γ rays gave methyl and $H_2COP(O)(OMe)_2$ radicals. The methyl radical was lost at ca. 120°K, and the ESR spectrum of the more stable radical at this temperature was characteristic of a system in which the α-hydrogen atoms were rapidly reorienting. (auth) (UK)

38922 OXIDES AND OXYIONS OF THE NON-METALS. PART XII. AN ELECTRON SPIN RESONANCE SPECTROSCOPIC STUDY OF THE CHLORATE ANION CENTRE IN IRRADIATED BARIUM SULPHATE. Bloom, M. B. D.; Eachus, R. S.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 8, 1235-8 (1970).

A radical prepared by the action of γ rays on barium sulphate doped with perchlorate anions was detected by ESR spectroscopy. The principal values of the g-tensor are $g_{11} = 2.0020$, $g_{22} = 2.0255$, and $g_{33} = 2.0325$, and those of the ^{35}Cl hyperfine tensor are $A_{11} = 74.6$, $A_{22} = 77.5$, and $A_{33} = 71.7$ G. The structure of the centre is discussed and by comparison with the radicals PF_4, PCl_4, SF_4^+, and AsO_4^{3-}, it is concluded that this species is the isoelectronic ClO_4^{2-} radical. (auth) (UK)

38923 FREE-RADICAL PRODUCTION BY HEAVY IONS AT 77°K AND ITS RELATION TO THE THERMAL SPIKE THEORY. Henriksen, Thormod; Horan, Paul Karl; Snipes, Wallace (Univ. of California, Berkeley). Contracts W-7405-eng-48; AT(30-1)-3799. Radiat. Res.; 43: 1-11(Jul 1970).

Polycrystalline samples of amino acids and proteins were exposed to electrons and beams of helium, carbon, neon, and argon ions from the Berkeley heavy-ion linear accelerator. Both the irradiations and the electron-spin resonance observations were carried out at 77°K. The results showed that the same types of radicals were formed independent of the stopping power of the bombarding particle. The results for the amino acid DL-valine were interpreted in relation to the thermal spike model. The irradiation of DL-valine at 77°K results in the formation of a radical which converts upon heat treatment into a secondary radical. On the basis of the thermal spike model and the kinetics for the radical conversion, it is possible to calculate the expected amount of secondary radicals formed at 77°K along the tracks of the heavy ions. The observation that no spectral changes take place with increasing stopping power is clearly in contrast to the predictions from the thermal spike model. Therefore, the model in its present form does not apply to radical formation or secondary radical reactions. (auth)

38924 RADIATION CHEMISTRY OF GELATIN GELS CONTAINING FERRICYANIDE. Stein, Gabriel; Tomkiewicz, Micha (Hebrew Univ., Jerusalem). Contract AT(30-1)-3242. Radiat. Res.; 43: 25-33(Jul 1970).

The G-value of the reduction of ferricyanide in gels containing up to 20% wt/wt gelatin increased with increasing protein concentration to a value corresponding approximately to the sum of the primary radicals, $G(e_{aq}^- + H + OH)$. In the presence of added N_2O a similar value was reached at lower gelatin concentrations. Added O_2 reduced the yield but did not eliminate the reduction process. The results were interpreted in terms of a mechanism involving intermediate organic free radicals, and an attempt was made to correlate the results with radical diffusion in gels. (auth)

38925 EFFECTS OF IONIZING RADIATIONS ON GLUCURONIC ACID. Phillips, G. O.; Worthington, N. W. (Univ. of Salford, Eng.). Radiat. Res.; 43: 34-44(Jul 1970).

The effects of radical scavengers and solute concentration indicated that the degradation of glucuronic acid by ^{60}Co γ irradiation is mainly due to OH radicals. Pulse radiolysis demonstrated no significant reaction of sodium glucuronate with e_{aq}^- ($k_2 \leq 10^6$ M^{-1} second^{-1}), but a facile reaction with OH radicals ($k_2 \sim 10^9$ M^{-1} second^{-1}). Moreover, a transient intermediate was produced, which appeared to be the result of OH radical abstraction and decayed by second-order kinetics ($k_2 \sim 10^7$ M^{-1} second^{-1}). Beyond 7.5×10^{-3} M solute concentration additional processes led to glucuronic acid degradation, which could not be accounted for on the basis of direct action effects. When irradiated in the solid state $-G$(glucuronic acid) = 4, but this was considerably reduced due to energy transfer if the p-toluidine-ammonium complex was irradiated. (auth)

38926 INVESTIGATION IN THE FIELD OF RADIATION POLYMERIZATION. XII. THE APPLICATION OF THE THERMOSTATIC METHOD IN GAMMA-IRRADIATION SOURCES BY THE POLYMERIZATION OF MALEIMIDES. POLYMERIZATION OF N-p-TOLYLMALEIMIDE. Goldin, V. A.; Migunova, I. L.; Ivanov, V. S.; Vinogradov, A. K. Vestn. Leningrad. Univ., No. 22, Fiz., Khim.; No. 4, 153-8(Nov 1969). (In Russian).

A special electrically heated thermostat was constructed and

tested for high-temperature radiation polymerization. The influence of temperature on the rate of the polymerization of N-p-tolylmaleimide was investigated. The apparent activation energy was 23 kcal/mole in the temperature range of 120 to 160°C. The post-polymerization of this monomer was studied under different conditions. (auth)

38927 RADICAL ADDITION OF METHANOL TO TRIFLUOROCHLOROETHYLENE. Liska, F.; Simek, S. (Inst. of Chemical Tech., Prague). Collect. Czech. Chem. Commun.; 35: 1752-9 (Jun 1970).

The radical addition of methanol to trifluorochloroethylene initiated by di-tert-butyl peroxide, ^{60}Co γ radiation, and ultraviolet light was investigated. The following adducts and telomers were isolated: 2,2,3-trifluoro-3-chloropropanol, 2,2,3,4,4,5-hexafluoro-3,5-dichloropentanol, 2,2,3,4,4,5,6,6,7-nonafluoro-3,5,7-trichloroheptanol, 2,2,3,4,4,5-hexafluoro-3,5-dichloropentanal, and 1,2,2,4,4,5,6,6,7-nonafluoro-1,5,7-trichloro-3-heptanol. The formation of 2,3,3-trifluoro-2-chloropropanol (III) and of 2,2,3,4,4,5-hexafluoro-5-chloropentanol (VIII) was evidenced. The IR and PMR spectra of individual products are described, and the mechanism of the reaction is discussed. (auth)

38928 PULSE RADIOLYTIC INDUCED TRANSIENT ELECTRICAL CONDUCTANCE IN LIQUID SOLUTIONS. PART I. TECHNIQUE AND THE RADIOLYSIS OF WATER. Barker, G. C.; Fowles, P.; Sammon, D. C.; Stringer, B. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Faraday Soc.; 66: 1498-1508(Jun 1970).

A sensitive technique is described for the study of transient ionic intermediates produced in the radiolysis of liquid solutions. Results are given for the radiolysis of water in the pH range 4 to 10. Rate constants for $e^-_{aq} + H_3O^+$ and $OH^- + H_3O^+$ are in good agreement with values obtained by other methods. Activation energies have been measured for both reactions and for the diffusion of the hydrated electron. (auth) (UK)

38929 RADIOACTIVATION ANALYSIS STUDIES OF POLYMERIZATION REACTIONS. 2. INITIATION MECHANISM IN RADIATION-INDUCED RADICAL POLYMERIZATION OF STYRENE. Maekawa, T. (Kyoto Univ.); Matsuo, M.; Yoshida, H.; Hayashi, K.; Okamura, S. Polymer; 11: 351-8(Jul 1970).

The structure of the free radicals, formed by radiolysis, which initiate the radioinduced polymerization of styrene in chloroform, methylene dichloride, ethylene dichloride, and bromobenzene, was determined by radioactivation analysis of the polystyrene formed. The initiation efficiency of the free radicals is discussed. Polymerization was initiated mainly by free radicals formed from solvent molecules, except when the mole fraction of the solvent was very low. With chloroform and ethylene dichloride as solvents, the polymerization was partly initiated by the secondary radicals; these were formed by the primary radicals generated during radiolysis abstracting hydrogen from solvent molecules. (auth) (UK)

38930 PULSE RADIOLYSIS OF THE EOSIN-HUMAN SERUM ALBUMIN COMPLEX. Husain, Ather; Ovadia, J.; Grossweiner, L. I. (Michael Reese Hospital and Medical Centre, Chicago). Trans. Faraday Soc.; 66: 1472-84(Jun 1970).

The radiolysis of the eosine human serum albumin (HSA) complex has been investigated with pulse radiolysis and ^{60}Co irradiation. The rate constant for the reaction of e^-_{aq} with eosine decreased from $(1.94 \pm 0.12) \times 10^{10}$ l/mole s in aqueous solution to $(9 \pm 1) \times 10^9$ l/mole s when the dye was fully bound to HSA at pH 12. The reaction led to the eosine semiquinone which was less strongly complexed to the protein than the dye. The G-value for reductive bleaching of the complexed dye by ^{60}Co in the presence of D-glucose was 0.28, which was consistent with the effective encounter cross section of the dye moiety. The reactions of hydroxyl radicals with HSA led to a decrease in the ability to bind eosine, associated with the loss of solubility and not a specific attack on the binding sites. (auth) (UK)

38931 A DETERMINATION OF W AND G(H_2) VALUES FOR METHYL FLUORIDE AND FLUOROFORM. Saca, M.; Lee, R. A. (Puerto Rico Nuclear Centre, Mayaguez). Can. J. Chem.; 48: 1812-14(15 Jun 1970).

Methyl fluoride and fluoroform were irradiated with gamma rays from a 1200-Ci ^{60}Co source. Ionization currents were measured using a Pyrex parallel-plate-type ionization chamber. W values of 27.2 and 28.0 eV were determined for the two gases, CH_3F and CHF_3, respectively. The method employed was a comparative one, making use of the Bragg–Gray theory of cavity ionization. G(H_2) yields of 4.20 and 1.25 for CH_3F and CHF_3, respectively, were then calculated from the above W values and the measured ion-pair yields for hydrogen. The formation of hydrogen is probably due to the fact that the C–H bonds in these compounds are weaker than the C–F bonds. (auth) (Canada)

38932 ESR STUDY OF THE γ-RAY INDUCED SOLID STATE POSTPOLYMERIZATION OF METHACRYLAMIDE. Faucitano, A. (Univ., Pavia, Italy). Chim. Ind. (Milan); 52: 427-32(May 1970).

The ESR spectra of polycrystalline samples of methacrylamide γ irradiated at −196°C and subsequently kept at various temperatures from −196°C up to +60°C have been studied. The polymerization is initiated by the radical $CH_3-\overset{CH_3}{\underset{CONH_2}{\overset{|}{\underset{|}{C^{\cdot}}}}}$ and is terminated by trapping the active chain ends within polymer nuclei. Most of the changes in the hyperfine structures observed in the temperature range −95°C to +20°C, can be attributed to conformational transitions of the growing chain radicals. The sequence of the conformations assumed by these radicals expressed in terms of dihedral angles between the $C_\beta - H_{(1,2)}$ bonds and the symmetry axis of the p_z orbital carrying the unpaired electron, is the following: $A(\vartheta_1 \simeq 10°, \vartheta_2 \simeq 70°) \rightarrow B(\vartheta_1 \simeq 46{,}5°, \vartheta_2 \simeq 73{,}5°) \rightarrow C(_1 \simeq 55°, \vartheta_2 \simeq 65°)$. The increase of the polymer concentration, when the sample is kept at +60°C, causes a back conversion to the B conformation. These transitions have been related to the various stages of the solid state polymerization. (auth)

38933 OXIDES AND OXYIONS OF THE NON-METALS. PART XIII. ELECTRON SPIN RESONANCE STUDIES OF THE PO_3^{2-} RADICAL AND RELATED SPECIES IN γ-IRRADIATED PHOSPHATES. Subramanian, S.; Symons, M.C.R.; Wardale, H. W. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 8, 1239-42 (1970).

The radical PO_3^{2-} is thought to be a product of the action of γ rays on calcium tungstate crystals doped with phosphate. The ESR data together with those for the related radicals O_2PF^- and O_2PF_2 are used as a guide in the interpretation of the ESR spectra obtained from a wide range of phosphates after exposure to γ rays at 77°K. (auth) (UK)

38934 UNSTABLE INTERMEDIATES. PART LXXII. ELECTRON SPIN RESONANCE SPECTRAL EVIDENCE FOR THE EXISTENCE OF THE $(AgH)^+$ AND $(Ag_2H)^{2+}$ RADICAL-CATIONS. Eachus, R. S.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 8, 1336-40(1970).

The exposure of frozen aqueous acids containing silver(I) salts to γ rays at low temperature results in the formation of a new paramagnetic species that has the properties expected for $[AgH]^+$ When the acid matrices are warmed this radical readily reacts with excess cations to form $[Ag_2H]^{2+}$. (auth) (UK)

38935 UNSTABLE INTERMEDIATES. PART LXX. AN ELECTRON SPIN RESONANCE STUDY OF SILVER RADICALS TRAPPED IN FROZEN AQUEOUS SULPHURIC ACID. Eachus, R. S.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 8, 1329-33(1970).

The low-temperature irradiation of frozen aqueous sulphuric acid containing Ag^I salts results in the formation of two inequivalent Ag^0 species. The more abundant radical has magnetic properties characteristic of an aquated complex, whereas the second species has an unusual, but highly specific structure. When the irradiated samples are annealed the isolated silver radicals aggregate to form polynuclear species, which have the properties expected for Ag_4^+ or Ag_4^{3+}. (auth) (UK)

38936 UNSTABLE INTERMEDIATES. PART LXIX. TRAPPED ELECTRONS: AN ELECTRON SPIN RESONANCE STUDY OF RADIATION DAMAGE IN HYDROGEN CYANIDE AND METHYL CYANIDE. England, R. J.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 8, 1326-9(1970).

A recent postulate by F. Williams and his co-workers that various organic cyanides can trap electrons in the dipole field of the molecules in the crystalline state was critically assessed by means of esr spectroscopy. An analysis of the esr spectra of γ-irradiated hydrogen cyanide and methyl cyanide suggests that this novel concept is unnecessary and that the species involved in the latter material is better described as a radical anion, $MeCN^-$, which, as a consequence of the crystal structure, is weakly bonded to a neighboring molecule in such a way that the electron is equally shared between two cyanide molecules. The major paramagnetic species in hydrogen cyanide irradiated at 77°K is H_2CN, and some evidence for the formation of H(Me)CN in methyl cyanide is also adduced. An analysis of the magnetic data for the radical CH_2CN is also reported. (auth) (UK)

38937 RECENT RESEARCH ON THE TRANSURANIUM ELEMENTS. Bagnall, K. W. (Univ. of Manchester, Eng.). Lab. Pract.; 19: 596-8(Jun 1970).

All the elements beyond uranium in the periodic table are synthetic, prepared primarily by neutron irradiation of uranium. This procedure fails for elements beyond fermium (atomic number 100). Elements of higher atomic number can be prepared only by bombarding the elements between uranium and fermium with charged particles. These methods, their limitations, and some of the possibilities for future work on the synthesis of elements of even higher atomic number are discussed. A brief description is given of the experimental techniques applicable to chemical research in this field and some of the more important recent results are discussed within the context of the chemistry of the actinide series. (auth) (UK)

38938 PULSE RADIOLYTIC INDUCED TRANSIENT ELECTRICAL CONDUCTANCE IN LIQUID SOLUTIONS. PART 2. RADIOLYSIS OF AQUEOUS SOLUTIONS OF NO_3^-, NO_2^-, AND $Fe(CN)_6^{3-}$. Barker, G. C.; Fowles, P.; Stringer, B. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Faraday Soc.; 66: 1509-19(Jun 1970).

A study has been made of the radiolysis of aqueous solutions of NO_3^-, NO_2^-, and $Fe(CN)_6^{3-}$ within the first millisecond after exposure to a submicrosecond pulse of 15-MeV electrons. The overall reaction of the electron adduct of NO_3^- with water had a time constant of 9.5 μs at 25°C and it was catalyzed by H^+. The reduction product of nitrite, $2OH^-$, appeared to originate from two processes with time constants of 18 and <2 μs respectively. The reduction of ferricyanide was probably complicated by aquocomplex formation. The rate constant for $CH_3OH + Fe(CN)_6^{3-} \rightarrow CH_2O + H^+ + Fe(CN)_6^{4-}$ was 4.2×10^9 l mole^{-1} s^{-1}. (auth) (UK)

38939 ENERGY TRANSFER IN AROMATIC SOLUTIONS. PART III. THE CORRELATION BETWEEN THE ^{60}Co-γ-INDUCED ISOMERIZATION YIELD AND THE FLUORESCENCE INTENSITY OF TRANS-STILBENE IN BENZENE AT 25°C AS A FUNCTION OF THE CONCENTRATION. Ehrl, A. (Gesellschaft fuer Strahlenforschung, Neuherberg, Ger.). Atomkernenergie; 16: 71-5(1970).

The initial yield G_i of the ^{60}Co-γ-induced isomerization at 25°C of both cis-stilbene and trans-stilbene dissolved in benzene was considerably increased if the isomer concentration was enlarged. Two factors could possibly account for this: (a) An energy loss from excited benzene could arise from fluorescence emission as well as from internal quenching. Both should be restricted, if the concentration of an acceptor such as stilbene was increased. (b) Furthermore an intensified interaction between the excited and unexcited acceptor stilbene could additionally influence the turnover of that species. Both suppositions were confirmed by fluorescence measurements: (a) At isomer concentrations between 5×10^{-6} M and 5×10^{-5} M the primarily excited benzene fluorescence was only partially quenched and the secondary fluorescence of trans-stilbene therefore had not its maximum intensity. Excitation energy was not completely transferred since the acceptor concentration was too low. (b) If the trans-stilbene concentration was increased from 10^{-4} M to 10^{-1} M beyond the complete quenching of the primarily excited benzene fluorescence an additional red shift of the secondary trans-stilbene fluorescence resulted. With direct excitation the fluorescence of trans-stilbene was reciprocal to the logarithm of the concentration. Both facts were an indication for self quenching as a result of stilbene interaction. This was in correlation with the ^{60}Co-γ-irradiation experiments which showed that the initial isomerization yield G_i was proportional to the logarithm of the concentration. Isomerization and fluorescence therefore were reciprocal phenomena at the deactivation of excited trans-stilbene. (auth)

38940 HIGH TEMPERATURE ANNEALING BEHAVIOR FOLLOWING THE ^{191}Ir(n,γ)^{192}Ir REACTION IN K_2IrCl_6. Jach, Joseph; Chandra, Prafulla (State Univ. of New York, Stony Brook). J. Inorg. Nucl. Chem.; 32: 1791-7(Jun 1970).

Annealing behavior of K_2IrCl_6 following the ^{191}Ir(n,γ)^{192}Ir reaction was studied in the temperature region where slow thermal decomposition occurs. The results appear to be similar to previous studies on a bromate system from which it was concluded that the labelled parent species exist as such in the solid rather than being formed after dissolution. (auth) (UK)

38941 NATURE OF BONDING IN SILVER–OLEFIN COMPLEXES: AN ELECTRON SPIN RESONANCE STUDY. Gee, D. R.; Wan, J. K. S. (Queen's Univ., Kingston, Ont.). J. Chem. Soc., D; No. 11, 641-2(1970).

Paramagnetic species have been detected in γ-irradiated silver perchlorate cycloalkene complexes at room temperature and identified as Ag^+ cycloalkenyl radical, with spin density on Ag ranging from 4.6% to 1.5% and in a decreasing order with increasing size of the alkene rings. (auth) (UK)

38942 RATE CONSTANTS OF HYDRATED ELECTRON, HYDROGEN ATOM, AND HYDROXYL RADICAL REACTIONS WITH BENZENE, 1,3-CYCLOHEXADIENE, 1,4-CYCLOHEXADIENE, AND CYCLOHEXENE. Michael, B. D.; Hart, Edwin J. (Argonne National Lab., Ill.). J. Phys. Chem.; 74: 2878-84 (23 Jul 1970).

The hydrated electron, H atom, and OH radical rate constants of reaction with benzene, 1,3-cyclohexadiene (1,3-C_6H_8), 1,4-cyclohexadiene (1,4-C_6H_8), and cyclohexene (C_6H_{10}) in aqueous solutions were determined by pulse radiolysis. In the order, e^-_{aq}, H, and OH, these rate constants in units of M^{-1} sec^{-1} are: C_6H_6, $(1.2 \pm 0.2) \times 10^7$, $(5.3 \pm 1.0) \times 10^8$, $(7.6 \pm 1.9) \times 10^9$; 1,3-$C_6H_8$, $(1.0 \pm 0.15) \times 10^9$, $(9.8 \pm 2.0) \times 10^9$, $(9.8 \pm 2.5) \times 10^9$; 1,4-$C_6H_8$, $<7.5 \times 10^5$, $(4.7 \pm 1.0) \times 10^9$, $(7.7 \pm 1.9) \times 10^9$; C_6H_{10}, $<10^6$, $(3.0 \pm 0.6) \times 10^9$, $(8.8 \pm 2.2) \times 10^9$. The hydrated electron rate constants were determined at pH 11 by the decay of its absorption at 715 nm. The H atom and OH radical rate constants were determined by measuring the reactivity of the hydrocarbon relative to p-nitrobenzoic acid (PNBA) at pH 2.0 and with its ion ($PNBA^-$) in neutral solution, respectively. The H-atom adduct of PNBA has a strong absorption band at 400 nm; the OH radical adduct of $PNBA^-$ has its band centered at 415 nm. By measuring the attenuation of these bands as a function of hydrocarbon concentration, their relative rate constants were determined. Spectroscopic evidence was obtained that OH reacts with 1,3-C_6H_8 and 1,4-C_6H_8 partly by H-atom abstraction to give C_6H_7; the proportions abstracting were 30 and 45%, respectively. (auth)

38943 ELECTRON SCAVENGING IN THE γ RADIOLYSIS OF LIQUID DIETHYL ETHER. Bansal, Krishan M.; Rzad, Stefan J. (Carnegie–Mellon Univ., Pittsburgh). J. Phys. Chem.; 74: 2888-92(23 Jul 1970).

The concentration dependence of electron capture in the γ radiolysis of diethyl ether–methyl bromide solutions can be quantitatively accounted for by the empirical model previously proposed for hydrocarbons and extended to alcohols. The free and geminate ion pair yields are estimated as 0.15 and 3.8, respectively. Competition experiments allowed the determination of the reactivities of SF_6 and N_2O towards electrons in the ether. From the study of the decrease in hydrogen yield upon addition of these electron scavengers, it is concluded that only 40% of the ion-neutralization processes yield hydrogen. (auth)

38944 STUDIES ON THE MOLECULAR HYDROGEN FORMATION (G_{H_2}) IN THE RADIATION CHEMISTRY OF AQUEOUS SOLUTIONS. Peled, E.; Czapski, G. (Hebrew Univ., Jerusalem). J. Phys. Chem.; 74: 2903-11(23 Jul 1970).

G_{H_2} in the γ radiolysis of air-free 0.01, 0.1, and 1 M solutions of various cations and anions were measured. The rate constants of most of these ions with e_{aq} at different ionic strength were directly determined by the pulse radiolysis technique. The effect of ionic strength on spur-reactions and on scavenging efficiency was studied. Difficulties previously observed, concerning the lack of correlation between $k_{e_{aq}+S}$ [S] and the scavenging efficiency of G_{H_2} were shown to be mainly due to ionic strength effects on $k_{e_{aq}+S}$. Hence it is concluded that e_{aq} is the main precursor of G_{H_2} through the reactions: $e_{aq} + H$ and $e_{aq} + e_{aq}$. It is suggested that $G^0_{H_2}$ and G^0_H (which were proposed by Schwarz to be formed directly) result from spurs which are characterized by initially higher radical concentrations. (auth)

38945 ELECTRON SPIN RESONANCE EVIDENCE FOR THE CATIONS Cd_2^{3+}, $AgCd^{2+}$, AND $AgHg^{2+}$. Eachus, R. S.; Marov, I.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., D; No. 11, 633(1970).

Analysis of the hyperfine coupling constants for these radicals produced by γ irradiation showed that the unpaired electrons are in σ-bonds comprising largely the outer s-orbitals of the atoms: these atoms have equal spin-densities in Cd_2^+ and $AgCd^{2+}$, but mercury is favored in $AgHg^{2+}$. (auth) (UK)

38946 REACTIONS OF ^{125}I AND ^{211}At WITH BENZENE DURING K CAPTURE FROM NOBLE GASES. Nefedov, V. D.; Toropova, M. A.; Khalkin, V. A.; Norseev, Yu. V.; Kuzin, V. I. Radiokhimiya; 12: 194-5(1970). (In Russian).

The products of the interaction of ^{125}I and ^{211}At atoms, which are formed as a result of K-capture from the respective isotopes of noble gases, with benzene were studied. Daughter products accumulated in the absence of light and at room temperature. The time of accumulation for ^{125}I was approximately 5 days, for ^{211}At, approximately 15 hours. Analysis of the chemical forms of iodine and astatine were made by extraction methods and thin-layer and gas chromatography. The measurement of ^{211}At was made by α and x-radiation. (R.V.J.)

38947 CHEMICAL FORMS OF STABILIZED ATOMS OF RADIOACTIVE RHENIUM FORMED BY THE IRRADIATION OF CER-

TAIN INORGANIC RHENIUM COMPOUNDS BY 660-MeV PROTONS. Zaitseva, N. G.; Ianovich, E. Radiokhimiya; 12: 143-8(1970). (In Russian).

The chemical forms of stabilized atoms of radioactive rhenium, formed upon irradiation of crystals of inorganic rhenium compounds ($NaReO_4$, $KReO_4$, NH_4ReO_4, K_2ReCl_6) with 660 MeV protons were studied after dissolution of the irradiated crystals in 4M HCl. On irradiation of the perrhenates of K and Na, practically all of the radioactive rhenium is stabilized as Re(VII). On irradiation of NH_4ReO_4 about one-third of the rhenium is stabilized in the tetravalent form, which is evidence of the restoring effect of the ammonium ions. On irradiation of K_2ReCl_6 most of the radioactive rhenium (65 to 80%) is stabilized in the form of the original molecule. The irradiation of solutions of rhenium salts leads to the stabilization of nearly all the radioactive rhenium in a higher oxidation state, Re(VII), independent of the valence of rhenium in the irradiated compound. A possible mechanism for the reactions is discussed. (tr-auth)

38948 KINETICS OF CONCENTRATION OF LABELED MOTHER SUBSTANCES DURING IRRADIATION OF ORGANIC COMPOUNDS BY ION FLUXES. Firsova, L. P.; Khar'ono, A. B.; Kuklin, Yu. S. Radiokhimiya; 12: 148-56(1970). (In Russian).

Labeled yields were studied as a function of the time of irradiation of chilled benzene and pyridine using tritium ion fluxes. A kinetic curve was obtained at various energies of ion flux from 6×10^{-7} to 5×10^{-9} A. An increase in time brought yields to maximum values. When the irradiation time is short, labeled yields depend linearly on the integral dose. (tr-auth)

38949 RADIOCHEMICAL COMPOSITION OF TARGETS OF ^{54}Fe SUBJECTED TO NEUTRON IRRADIATION FOR PRODUCTION OF MACROQUANTITY ^{55}Fe. Volkov, V. V.; Sokolova, V. K. Radiokhimiya; 12: 163-72(1970). (In Russian).

A theoretical investigation was conducted on the processes of isotope transformation in neutron-irradiated targets of ^{54}Fe, and results were compared with experimental data. In addition to ^{55}Fe, it was found that ^{59}Fe, ^{54}Mn, and ^{51}Cr are formed when the ^{54}Fe target is irradiated with a flux of 10^{22} neutrons/cm^2. Significant quantities of radioactive isotopes are also formed by activation of impurities in the material. The radiolytic reduction of Fe^{3+} to Fe^{2+} was observed in HCl solutions. Fe^{2+} makes up 11 to 12% of the total quantity of Fe. (tr-auth)

38950 CONCERNING THE KINETICS OF FORMATION OF DIFFUSED COLOR RADIATION CENTERS IN SYNTHETIC QUARTZ. Samoilovich, M. I.; Gordienko, L. A.; Tsinober, L. I. Radiokhimiya; 12: 124-7(1970). (In Russian).

The effects of γ and x radiation on the formation of diffused color centers in quartz were studied. It was found that the kinetics of formation of the color centers depend on the conditions of crystal growth and on the concentration of various kinds of defects in the crystalline lattices which capture electrons. (R.V.J.)

38951 EFFECT OF INTERNAL α IRRADIATIONS ON THE CHARACTERISTICS OF ANION EXCHANGER AB-23M. Paramonova, V. I.; Vysokoostrovskaya, N. B.; Nikolaev, V. M.; Osipov, S. V.; Frolov, V. I. Radiokhimiya; 12: 127-32(1970). (In Russian).

The effects of internal α radiation on certain properties of vinylpyridine anion exchanger AB-23M × 7 were studied. At a dose of 2.57×10^3 rad the basicity of the resin is not changed. The main result of the action of the α radiation is the breakdown of the crosslinking of the resin. This is manifested in an increase in swelling and a decrease in the strength of grains of the resin. It was established that internal irradiation of a resin leads to its decomposition, with complete decomposition occurring at a dose of $(2.5 \text{ to } 3.8) \times 10^4$ g·hr ^{239}Pu/kg of absolutely dry resin. It was found that ^{239}Pu sorbed on the resin gradually passes into the aqueous solution as a result of oxidation up to the hexavalent state and also the disintegration of resin. The quantity of irreversibly sorbed Pu increases with the dose of radiation; however, even at a maximum dose the quantity is insignificant. (tr-auth)

38952 E.S.R. OF RADICALS IN γ-IRRADIATED HEPTASULPHURIMIDE S_7NH AND TETRASULPHURTETRAIMIDE, $S_4(NH)_4$. Machmer, P.; McNeil, D. A. C.; Symons, M. C. R. (Leicester Univ., Eng.). Trans. Faraday. Soc.; 66: 1309-11(Jun 1970).

The major species in both compounds at room temperature had similar ESR spectra which were interpreted in terms of π-radicals R_2N, having the unpaired electron largely confined to nitrogen. Loss of a hydrogen atom from the parent molecules accords with this result. Another species, detected at 77°K only, had no detectable hyperfine coupling to ^{14}N or ^1H. The g-tensors accord with expectation for radicals having the unpaired electron largely confined to sulphur. A secondary radical, detected in S_7NH, characterized by hyperfine coupling to one nitrogen atom, is also described but not identified. (auth) (UK)

38953 FORMATION OF DEOXYCOMPOUNDS AND MALONDIALDEHYDE IN IRRADIATED AQUEOUS SOLUTIONS OF CARBOHYDRATES AND RELATED COMPOUNDS. Scherz, Heimo (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Radiat. Res.; 43: 12-24(Jul 1970).

The formation of malondialdehyde and deoxycompounds in aqueous solutions of carbohydrates and related compounds by irradiation with 10-MeV electrons and ^{60}Co γ rays was investigated. The G-values for these substances were determined as a function of the pH in the absence of oxygen. For the deoxycompounds G-values below 0.1 were obtained at pH 2.0 to 4.5. In the range of pH 5.0 to 8.0 the G-values increased greatly, being 0.3 for most of the carbohydrates and 0.7 for some sugar alcohols. Free malondialdehyde appeared at pH 6.0 to 7.0. Its concentration increased sharply above pH 10, reaching G-values close to 1.0 at pH 13. In acid medium free malondialdehyde was found only in irradiated solutions of pentoses, fructose, glyceraldehyde, and glycerol. Studies using electron- and OH'-radical scavengers (N_2O, Br^-) indicated that the reactions are due to the OH'-radical. The mechanism of these reactions is discussed. (auth)

38954 FORMATION OF RADICALS DURING LOW-TEMPERATURE RADIOLYSIS OF TRIBUTYL PHOSPHATE AND CERTAIN OTHER PHOSPHOORGANIC EXTRACTANTS. Vashman, A. A.; Savel'ev, Yu. I. Radiokhimiya; 12: 12-17(1970). (In Russian).

Electron paramagnetic resonance methods were used to study free radicals formed during the γ irradiation of TBP and certain other neutral phosphoorganic extractants. The formation of radicals in irradiated mixtures of TBP and nitric acid with inert diluents was also studied. When neutral phosphoorganic extractants are irradiated, free radicals are formed at the expense of the breaking away of hydrogen atoms in the hydrocarbon chains of the extractant molecules. The structures of these radicals were identified according to EPR spectra. (tr-auth)

38955 ISOLATION OF AMERICIUM AND CURIUM ON METALS BY DROP ELECTROLYSIS AS A METHOD OF OBTAINING SPECTROMETRIC ALPHA SOURCES. Surin, V. M.; Smirnova, G. D.; Stabrovskii, A. I.; Vesnovskii, S. P. Radiokhimiya; 12: 379-88(1970). (In Russian).

The electrolytic isolation of americium and curium on metals and alloys from drops (0.05 ml) of 0.001 to 0.01N solutions of HNO_3 at $Cm(NO_3)_3$ concentrations of 5.4×10^{-9} to 8.2×10^{-8}M and $Am(NO_3)_3$ concentrations of 6.1×10^{-8} to 1.2×10^{-7}M was studied. The completeness of isolation of americium or curium on the electrode is a function of the concentration of the dissolved salt and the acidities of the solutions. It was concluded that the mechanism of isolation has a double character: ion exchange adsorption and hydrolysis followed by precipitation. This method is shown to give alpha sources with high resolution and is suitable for obtaining forms with several groups of alpha particles of different energies. (tr-auth)

38956 IMPROVEMENTS IN OR RELATING TO POLYMERIC BODIES. Whittaker, Brian (to United Kingdom Atomic Energy Authority). British Patent 1,195,533. 17 Jun 1970. Filed 15 Jun 1966.

Irradiation, without a catalyst, was used to effect polymerization incorporating a metal compound into a plastic. The monomer is subjected to γ irradiation at about 20°C, the dose employed being dependent on the energy of the radiation, the dose rate, and the particular monomer. With methyl methacrylate monomer and using a ^{60}Co source at a dose rate of 0.05 MR/hr a dose of 0.2 to 2 MR gives satisfactory polymerization, although much higher doses may have certain advantages. Preferably a low dose rate $< 1 \times 10^3$ R/hr is used in order to avoid bubble formation due to overheating resulting from the exothermic polymerization reaction. Using such a low dose rate permits the polymerization to be effected in a single step, whereas with higher dose rates polymerization must be effected in two stages, during the first of which partial polymerization occurs to give a syrupy liquid, which is degassed under reduced pressure before further irradiation. The method has been applied to the production of polymethyl methacrylate bodies, and may also be applied to other plastics, such as polyvinyl acetate, polybutyl acrylate, or other acrylic materials. Metal compounds which have been incorporated include cobalt thiocyanate complexes and Co(III)-1-nitroso-2-naphtholate; also rare earth benzoyl acetonates, and rare earth complexes of salicyl aldehyde and dibenzoylmethane. Several examples are described. (UK)

38957 ELECTRON STABILIZATION IN CRYSTALLINE ICE WITH ALCOHOL ADMIXTURE γ-IRRADIATED AT 77°K. Puntezhis, S. A.; Ershov, B. G.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ.; 4: 187-8(Mar-Apr 1970). (In Russian).

Optical spectra of electrons in a γ-irradiated crystalline ice containing from 0.1 to 1.0 M alcohol (methanol, ethanol, or isopropanol) were studied for specimens irradiated at ~4×10^{20} eV/g and 77°K. The appearance of coloration on irradiation was observed. The maximum optical absorption was observed at 515, 540, and 600 nm for methanol, ethanol, and isopropanol, respectively. With an increase in alcohol content the optical absorption of captured electrons increased, indicating that electrons localized in alcohol traps. It was postulated that in frozen solutions electrons are stabilized in vitreous-type pure alcohol microphases formed during freezing of the solution. (R.V.J.)

38958 EXTINCTION OF CAPTURED ELECTRONS IN γ-IRRADIATED ALKALINE GLASS AT 77°K. Ershov, B. G.; Tseitlin, E. L. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ.; 4: 186-7(Mar-Apr 1970). (In Russian).

Investigations were made of the spontaneous extinction of captured electrons in aqueous solutions of sodium hydroxide at 77°K in the presence of electron acceptors such as nitrate, nitrite, and ferricyanide ions. The dose rate was 6×10^{15} eV/g.sec. Captured electrons were recorded by the method of optical spectroscopy. The spontaneous extinction was probably caused by the tunneling of electrons to the acceptors. (tr-auth)

38959 STUDY BY THE METHODS OF NUCLEAR GAMMA RESONANCE AND EPR OF THE EFFECT OF PROTON IRRADIATION OF IRON OXALATES. Eremin, L. P.; Shipatov, V. T.; Tarasov, V. A.; Seregin, P. P. (Leningrad State Univ.). Khim. Vys. Energ.; 4: 185-6(Mar-Apr 1970). (In Russian).

An investigation was made by the methods of EPR and nuclear gamma resonance of the consequences of irradiation of iron oxalates by 5-MeV protons. The irradiation was carried out in air at room temperature. There was a noticeable decrease in the magnitude of the spectra of the trivalent iron oxalate in comparison with that of the divalent iron oxalate. (tr-auth)

38960 RADIATION-CATALYTIC ACTIVITY OF DIAMOND AND GRAPHITE. Vladimirova, V. I.; Zhabrova, G. M.; Kadenatsi, B. M.; Krivenkova, P. G.; Butuzov, V. P.; Korolev, D. F. (Inst. of Chemical Physics, Moscow). Khim. Vys. Energ.; 4: 182-3 (Mar-Apr 1970). (In Russian).

The characteristics of radiation-catalytic processes are the transfer of energy absorbed on a solid surface to molecules adsorbed on the surface. The role of the chemical nature of the substance and especially of its electronic properties was considered. A comparison was made of the radiation-catalytic activity of diamond and graphite, the same chemical substance, but in different electronic modifications. Samples of these substances with adsorbed methanol were irradiated with gamma rays. Comparative data on diamonds and graphite are given. Diamonds were good transmitters of energy and radiation-catalytic activity was possessed by both natural and synthetic forms. Graphite did not transfer adsorbed energy and is not a radiation catalyst. These results confirmed that the highest radiation activity is found in insulators. (tr-auth)

38961 STUDY BY THE METHOD OF ELECTRON SPIN RESONANCE OF THE SPACE DISTRIBUTION OF RADICALS IN α AND γ RADIOLYSIS OF METHANOL AND AQUEOUS SOLUTIONS OF H_2SO_4 AT 77°K. Raitsimring, A. M.; Moralev, V. M.; Tsvetkov, Yu. D. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). Khim. Vys. Energ.; 4: 180-2(Mar-Apr 1970). (In Russian).

The distribution of radicals from the radiolysis is determined both by the properties of the irradiated solid and the radiation. From the models for solid radiolysis, it was expected that the essential effect on the character of the radical distribution is the linear energy transfer (LET) of the radiation. Results confirmed this expectation. (tr-auth)

38962 INHIBITION OF THE PROCESS OF ENERGY TRANSFER IN REACTIONS OF HOT ATOMS AND RADIOLYSIS OF AROMATIC SYSTEMS. Filatov, E. S.; Kukin, P. P. (Moscow State Univ.). Khim. Vys. Energ.; 4: 177-8(Mar-Apr 1970). (In Russian).

Analyses were made of the mechanisms of formation of dimeric and bicyclic products from the radiolysis of benzene, chlorobenzene, and their mixtures and of the formation of labeled products that emerge on reaction of hot tritium atoms with the compounds. (tr-auth)

38963 PARAMAGNETIC CENTERS IN IRRADIATED SYNTHETIC ZEOLITES. Breslav, Yu. A.; Kotov, A. G. Khim. Vys. Energ.; 4: 149-53(Mar-Apr 1970). (In Russian).

The EPR spectra of paramagnetic centers in LiA, NaA, Ka, RbA, CsA, CaA, and SrA zeolites gamma-irradiated at 77 and 300°K were studied. The paramagnetic adsorption of oxides and nitrogen dioxides on nonirradiated and irradiated zeolite forms was also studied. The replacement of the alkali metal cation with the alkaline earth led to sharp changes in the properties of the surface. The donor electron levels of the surface defects were transformed to acceptor. These properties were kept on modification of defects as a result of heat treatment and on change in temperature of irradiation. (tr-auth)

38964 FORMATION AND STABILIZATION OF Cr(V) DURING RADIATION-CHEMICAL OXIDATION OF CHROMIUM HYDROXIDE COPRECIPITATED WITH ZIRCONIUM HYDROXIDE. Lesnikovich, A. I.; Sviridov, V. V.; Poznyak, A. G. (Belorussian State Univ., Minsk). Dodlady Akad. Nauk BSSR; 14: 240-2(Mar 1970). (In Russian).

The oxidation of gels of coprecipitated chromium and zirconium hydroxides and chromium and aluminum hydroxides induced by irradiation with gamma rays and formation of pentavalent chromium in a rather stable state are reported. The hydroxides were obtained by the addition of mixtures of saturated solutions of the salts in a double excess of concentrated ammonia. The mixtures were washed and dried at 55°C and irradiated with gamma rays from a cobalt source at 20°C. EPR spectra were recorded. In the reflection spectra, absorption bands appeared, coinciding with the absorption of CrO_4^{3-} ions. The ease in effecting radiation-chemical oxidation of Cr(III) in the hydroxide is caused probably by the loose structure of the hydroxide, as a result of which there are favorable conditions for assimilation of excess oxygen near the chromium. (tr-auth)

38965 EVIDENCE FOR VERY EARLY IONIC EVENTS IN THE RADIOLYSIS OF ETHANOL. Khorana, Shamsher; Hamill, William H. (Univ. of Notre Dame, Ind.). J. Phys. Chem.; 74: 2885-8(23 Jul 1970). (COO-38-717).

Very early ionic events in polar systems, e.g., $<10^{-11}$ sec, precede dipole relaxation and they are expected to resemble in part those which occur in alkanes. Reactions or reaction efficiencies which are markedly enhanced in alkanes provide suitable tests. Benzene, as an additive, traps electrons efficiently in alkanes but reacts slowly with solvated electrons, e_s^-, with $k(e_s^- + C_6H_6) \cong 10^7$ M^{-1} sec^{-1}. In contrast H_s^+ reacts very fast with e_s^- and not measurably with the dry electron, e^-. Preceding solvation, H_2O^+ or $C_2H_5OH^+$ will oxidize, or be scavenged by, Cl_s^-, while $H_3O_s^+$ is a much weaker oxidant. Ethanol solutions were chosen for study because $G(e_s^-) \cong 1$ and $G(e^-)$ should be large. Addition of 0.1 M alkyl halide RX was used to scavenge all e_s^- and some e^- and the yield was measured as G(RH). Added $CaCl_2$ increased G(RH) and is attributed to hole scavenging followed by $e^- \rightarrow e_s^-$. Addition of acid decreased G(RH) to a limit of ~50%, with $G^0(e_s^-) = 1.0$, but further addition of benzene decreased G(RH) considerably. Addition of benzene to neutral 0.1 M RX decreased G(RH) with $G^0(e^-) = 1.1$. (auth)

38966 RADIOLYSIS OF THE HEXAMMINOCOBALTIC NITRATE IN AQUEOUS SOLUTIONS. Murgulescu, I. G.; Mihalcea, I. (Univ. of Bucharest). Rev. Roum. Chim.; 15: 3-10(Jan 1970).

The kinetics and the mechanism of the hexamminocobaltic nitrate decomposition in aqueous solutions under the action of γ radiation are studied. The decomposition of the $[Co(NH_3)_6](NO_3)_3$ takes place according to a reduction mechanism of Co(III) to Co(II) by hydrogen atoms. The radiolysis process is studied for various concentrations of the hydrogen ions and the rate constant of the complex with the hydrogen atoms is determined. The influence of the dose rate and of the temperature on the yield of the complex decomposition is studied. The activation energy of the process is determined. (auth)

38967 ENERGY-LOSS RATES OF SLOW ELECTRONS IN HYDROCARBONS. Klots, Cornelius E.; Reinhardt, P. W. (Oak Ridge National Lab., Tenn.). J. Phys. Chem.; 74: 2848-50(9 Jul 1970).

The stopping power of low-energy electrons was measured in hydrocarbon vapors, and the results are presented graphically as a function of electric field strength. The stopping rates were also obtained as a function of characteristic energy. From the results obtained and from theoretical considerations, the gas-phase mobilities, when corrected to the density of liquids, are shown to be similar and ~$7 cm^3$/sec V in magnitude. This large value is interpreted to imply that electron-scavenging reactions in the liquid are not diffusion controlled. (B.L.M.)

38968 γ RADIOLYSIS OF CYCLOHEXANE–PERFLUOROCYCLOHEXANE SOLUTIONS. Fallgatter, Michael B.; Hanrahan, Robert J. (Univ. of Florida, Gainesville). J. Phys. Chem.; 74: 2806-10(9 Jul 1970).

An investigation was made of the products from the ^{60}Co γ radi-

olysis of liquid-phase mixtures of cyclohexane and perfluorocyclohexane over the entire concentration range from pure fluorocarbon to pure hydrocarbon. All experiments were done at 64°C, at which temperature the two compounds are completely miscible. In general, the products obtained over most of the concentration range are the main products characteristic of the radiolysis of pure cyclohexane, namely hydrogen, cyclohexene, and bicyclohexyl. The yields of hydrogen and cyclohexene are decreased in such a way as to suggest fairly efficient scavenging, but the bicyclohexyl yield is actually enhanced compared to pure cyclohexane. The only major organic product deriving from perfluorocyclohexane is c-$C_6F_{11}H$. A small yield of mixed dimer, possibly formed in a spur reaction, is also found. These results apparently require that cyclohexyl radicals do not react with perfluorocyclohexane, but that perfluorocyclohexyl radicals efficiently abstract hydrogen from cyclohexane. It is suggested that perfluorocyclohexane undergoes electron capture followed by dissociation, either directly or in a subsequent step. (auth)

38969 RADIATION-INDUCED DECOMPOSITION OF INORGANIC MOLECULAR IONS. Johnson, Everett R. New York; Gordon and Breach, Science Publishers, Inc. (1970). 150p. $14.50.

The literature on the effects of high-energy radiation on inorganic solids is reviewed. Nitrates, chlorates, perchlorates, bromates, azides, and permanganates are considered in detail. (J.G.B.)

38970 SOME ASPECTS OF THE DEVELOPMENT OF APPLIED RADIATION CHEMISTRY. Proesch, Ullrich (Institut fuer Angewandte Isotopenforschung, Berlin). Chem. Tech. (Leipzig); 22: 240-3(Apr 1970). (In German).

The application of radiation chemistry in industry is discussed. Processes by which radiation causes changes in substances are considered. Use of radiation chemistry for determining reaction mechanisms is described. Ionizing radiation as a process parameter is discussed. (M.C.G.)

38971 TRAPPING OF ELECTRONS IN LOW-TEMPERATURE GLASSES. A PULSE RADIOLYSIS STUDY. Richards, J. T.; Thomas, J. K. (Argonne National Lab., Ill.). J. Chem. Phys.; 53: 218-24(1 Jul 1970).

The pulse radiolysis of 3-methylpentane, 3-methylhexane, 2-methyltetrahydrofuran, cumene, ethanol, and alkaline ice glasses were studied at 77°K using 12-nsec pulses of 3-MeV electrons. Trapped electrons in varying yields were observed in all cases and in some instances short-lived species were observed. These short-lived transients have been correlated with different trap depths in the various media, and the trapping process and types of sites were discussed. The effect of carbon tetrachloride and biphenyl on the transients observed in 3-methylhexane was studied and the results interpreted in terms of electron capture by these solutes in accord with previous ^{60}Co γ-radiolysis data. Addition of positive hole scavengers to the later system was also investigated. Pulse radiolysis of 10^{-2}-M naphthalene in 3-methylhexane glasses at 77°K produced small yields of solute ions, which recombined on warming to about 123°K giving the naphthalene triplet (G = 0.95) and naphthalene singlet. (auth)

38972 EFFECT OF IONIZING RADIATION ON THE STABILITY OF CHROMIUM HYDROXIDE SOL. Wang, Jy-shih. Bull. Inst. Chem., Acad. Sinica; No. 17, 25-8(Apr 1970).

The deep green chromium hydroxide sol of pH 4.3 was prepared by the reaction of saturated chromium chloride and ammonium carbonate solutions. The radiation effects on the stability of the sol brought about by ^{60}Co gamma rays and x rays were recorded in terms of the changes in specific conductivity and pH value after irradiation. The specific conductivity of sol was found to be continuously increased after irradiation with ^{60}Co or x rays whereas the pH value showed a concomitant decrease. The diluted sols were quite stable towards the action of radiation energy. There was no visible change of color of the sol during irradiation. (auth)

38973 RADIOLYSIS OF METHANOL AND ITS SOLUTIONS. Hung, Tsu-chang. Bull. Inst. Chem., Acad. Sinica; No. 17, 84-92(Apr 1970).

An interesting induction effect has been observed in the irradiation of pure methanol and methanol–acetic solutions with variable pH values. The induction dose was proportional to the initial oxygen content of the methanol solution. During the induction period, low G-value of ethylene glycol ($0.45_5 \pm 0.1$ molecules/eV) was calculated in the case of the irradiation of pure methanol. After the induction period, G-value of ethylene glycol, linear with dose, was increased to 12.5 molecules/100 eV. An increment of G-value of ethylene glycol during the addition of acetic acid or acetic anhydride was observed. Both the hydrogen atom and the methyl radical affected the increase of the G-value of ethylene glycol. The mechanisms of oxygen competition with methanol for both solvated electron and hydrogen atom are discussed. (auth)

38974 ELECTRON SPIN ECHO TECHNIQUE FOR SPATIAL RADICAL DISTRIBUTION INVESTIGATION IN IRRADIATED SOLID SUBSTANCES: INFLUENCE OF LET AND SPUR EFFECTS. Tsvetkov, Yu. D.; Raitsimring, A. M. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). Radiat. Eff.; 3: 61-4 (May 1970).

Measurements of transversal relaxation times in the two-pulse Electron Spin Echo method of radicals trapped in α- and γ-irradiated frozen solution of H_2SO_4 and in methyl alcohol yields information on spatial distribution of trapped radicals. The results testify to the essential influence of the LET of radiation on the nature of spatial radical distribution and can be explained on the basis of the spur-and-track model. Average distances between radicals in tracks and spurs, and the number of radicals in spurs were calculated from relaxation data. (auth)

38975 RADIATION DAMAGE OF POLYMERS IN THE MILLION VOLT ELECTRON MICROSCOPE. Thomas, L. E.; Humphreys, C. J.; Duff, W. R.; Grubb, D. T. (United States Steel Corp. Research Center, Monroeville, Pa.). Radiat. Eff.; 3: 89-91(May 1970).

The degradation of polyethylene and polyoxymethylene crystals in the high voltage electron microscope was determined from 100 to 1000 kV. As in previous work at lower electron energies, the dose needed to change the initial crystalline diffraction patterns into amorphous ring patterns was measured. It was found that the dose required to destroy the crystal order increases by a factor of about three in going from 100 to 1000 kV. The result agrees roughly with the theoretically predicted ionization rate, assuming that the damage rate is proportional to the ionization rate. (auth)

38976 ESR STUDIES OF THE PHOTODEGRADATION OF POLYETHYLENE CONTAINING TRAPPED ALLYLIC FREE RADICALS. Shimada, S.; Kashiwabara, H.; Sohma, J. (Hokkaido Univ., Sapporo). J. Polym. Sci., Part A-2; 8: 1291-1302 (Aug 1970).

Changes produced in γ-irradiated polyethylene by subsequent ultraviolet irradiation were investigated by ESR measurements, ultraviolet spectroscopy, and viscometric determination of average molecular weight. The photoinduced changes depend on the wavelength of irradiation. Upon irradiation at wave length greater than 3900 Å, main-chain scission occurs by reaction of trapped allylic radicals: $\sim\sim CH_2-CH_2-CH_2-CH_2-\dot{C}H-CH=CH-CH_2\sim\sim \rightarrow \sim\sim CH_2-CH-CH_3 + CH_2=CH-CH=CH-CH_2\sim\sim$ A reduction in molecular weight indicated by this reaction was verified by fractionation experiments and molecular weight determinations. (auth)

38977 PULSE RADIOLYSIS STUDIES. XVIII. SPECTRUM OF THE SOLVATED ELECTRON IN THE SYSTEMS ETHYLENEDIAMINE–WATER AND AMMONIA–WATER. Dye, James L. (Michigan State Univ., East Lansing); DeBacker, Marc G.; Dorfman, Leon M. J. Chem. Phys.; 52: 6251-8(15 Jun 1970).

The pulse radiolysis technique with fast infrared detection was used to determine the optical absorption spectrum of the solvated electron in the systems ethylenediamine–water and ammonia–water. These spectra, determined over the entire concentration range, show the following: In ammonia and in ethylenediamine, the bands at 1550 and 1350 nm, respectively, have the same shape and position as those attributed to the solvated electron in alkali metal solutions. In each of the two-component systems a single band is seen with the peak position intermediate to those in the pure solvents. For ethylenediamine–water mixtures, the band shape (normalized) and half-width (energy scale) are invariant with composition, while for ammonia–water mixtures the ratio of the peak position to the half-width is invariant. These observations suggest a delocalized electron with optical characteristics determined by the aggregate properties of the solvent. Models which require that the optical properties be strongly influenced by solvation with a small number of solvent molecules are not in accord with these observations. Kinetic data indicate that the decay of the solvated electron in ammonia and in ethylenediamine is a complex process. The rate constant for the reaction of the solvated electron in ammonia with ammonium ion was found to be at least four orders of magnitude lower than the diffusion-controlled limit. (auth)

38978 ELECTRON SPIN RESONANCE OF Pd(I). I. γ-IRRADIATED BIS(ACETYLACETONATO)PALLADIUM(II). Fujiwara, Shizuo; Nakamura, Michihiro (Tokyo Univ.). J. Chem. Phys.; 52: 6299-6301(15 Jun 1970).

A paramagnetic complex produced in γ-irradiated bis(acetylacetonato)palladium(II) [Pd(II)(acac)$_2$] was studied by means of

the electron spin resonance technique. It is found that the same complex is produced by the uv irradiation of the frozen solution of Pd(II)(acac)$_2$ and N, N, N', N'-tetramethylparaphenylenediamine (TMPD) in ethanol. In this case, it is most probable that Pd(II)(acac)$_2$ was reduced by the electrons photoejected from TMPD. The g tensor for the paramagnetic complex produced in the γ-irradiated single crystals exhibits axial symmetry with the $g_\parallel$ direction coincident with that for CU(II)(acac)$_2$ which is diluted in Pd(II)(acac)$_2$. In view of these results it is concluded that [Pd(I)(acac)$_2$]$^-$ has been produced by the above procedures. The ESR parameters for this complex are interpreted in terms of the molecular-orbital theory developed by Maki and McGarvey, and the covalent character of the metal–ligand bond is compared with that for Cu(II)(acac)$_2$. (auth)

38979 DETERMINATION OF ELECTRON THERMALIZATION TIMES IN IRRADIATED GASES. Warman, John M.; Sauer, Myran C. Jr. (Argonne National Lab., Ill.). J. Chem. Phys.; 52: 6428-9(15 Jun 1970).

Argon was ionized by a 3-nsec pulse of 660-keV x rays. The electron concentration was monitored as the change in resonant frequency of a microwave cavity, which contained the gas. A reduction in electron lifetime due to electron capture by CCl_4 additive was apparent. (M.C.G.)

38980 ESR STUDY OF γ-IRRADIATED SINGLE CRYSTALS OF COPPER ACETATE MONOHYDRATE. Sakaguchi, Ushio; Arata, Yoji; Fukiwara, Shizuo (Tokyo Univ.). J. Chem. Phys.; 53: 464-5(1 Jul 1970).

ESR measurements were made on γ-irradiated single crystals of copper acetate monohydrate. Examples of spectra are shown and discussed. (M.C.G.)

38981 RESOLUTION OF STRUCTURE IN TRAPPED-ELECTRON SPECTRA. Hamill, William H. (Univ. of Notre Dame, Ind.). J. Chem. Phys.; 53: 473-4(1 Jul 1970).

The spectra of trapped electrons in irradiated 3-methylhexane and methyltetrahydrofuran are discussed. It is suggested that change in spectra is due to an optical transition to a bound state that did not exist in the unrelaxed system because the potential well was too shallow. (M.C.G.)

38982 CORRELATION OF ESR AND OPTICAL SPECTRA FROM FIVE X-IRRADIATED AMINO ACIDS. Shields, Howard W.; Marsh, William; Hamrick, Phillip J. Jr. (Wake Forest Univ., Winston-Salem, N. C.). J. Chem. Phys.; 52: 6437-8(15 Jun 1970).

Single crystals of glycine, alanine, aspartic acid, valine, and leucine were irradiated with about 10^5 rad of 50 kV x radiation and the optical spectra obtained. It was concluded that optical absorptions near 250 and 350 nm may be used to characterize trapped radicals of the form $R_1R_2\dot{C}COOH$ in nonconjugated organic solids. (M.C.G.)

38983 EPR STUDY OF RADIATION DAMAGE OF DEUTERATED SINGLE CRYSTAL OF THYMIDINE. Herak, J. N. (Inst. Rudjer Boskovic, Zagreb). J. Chem. Phys.; 52: 6440-1(15 Jun 1970).

Deuterated thymidine crystals were irradiated with γ rays at 77°K and studied by EPR. The possibility that irradiation causes displacement of the hydrogen atom bound to N_3 position of the thymine base and deuteron-proton exchange of thymidine radicals are discussed. (M.C.G.)

38984 ATOM CAPTURE BY SURFACES DURING n,γ REACTIONS. Cardito, J. M.; Diethorn, W. S. (Pennsylvania State Univ., University Park). J. Inorg. Nucl. Chem.; 32: 2133-40(Jul 1970).

New evidence is presented for a charged particle mechanism in the capture by surfaces of products produced by n, γ reactions in gases. Experiments with a graphite powder in argon, argon–air, and argon–helium suggest that charge exchange and ion production by Compton electrons are important in the capture process. (auth) (UK)

Radiochemistry

Refer also to abstract 38815.

38985 (NP-18348) OXIDATION KINETICS OF CARRIER FREE TETRAVALENT PROTACTINIUM IN AQUEOUS SOLUTIONS. Manier, Michel (Paris Univ. (France). Faculte des Sciences). Jun 1970. 34p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

Two methods for preparing carrier free tetravalent protactinium aqueous solutions free of any reducing agent able to stabilize the lower oxidation state of this element are developed. Then the oxidation rate of ^{233}Pa(IV) in $HClO_4$, HCl, HNO_3, and H_2SO_4 media and particularly the effect of temperature, ionic strength, and dielectric constant are studied. The ^{233}Pa(IV) concentration was measured as a function of time by coprecipitation of $^{233}PaF_4$ with ThF_4 under such conditions as would maintain ^{233}Pa(V) in solution. The oxidation reaction of ^{233}Pa(IV) is found to be of the first order with respect to ^{233}Pa(IV) concentration. For a (H^+) concentration range between 1 and 4N, the stability of ^{233}Pa(IV) in these complexing media decreases from the hydrochloric acid solutions to the sulfuric and nitric ones. In these conditions of acidity, ^{233}Pa(IV) is not stable in perchloric medium. Results concerning the dilution of ^{233}Pa(IV) solutions and the oxidation-reduction reactions of ^{233}Pa(IV) with various oxidizing agents are presented in two appendices. (France)

38986 CHEMICAL EFFECTS OF β^--DECAY IN ^{132}Te-LABELLED TELLURIC ACID. Jones, C. H. W.; Warren, J. L. (Simon Fraser Univ., Burnaby, British Columbia). J. Inorg. Nucl. Chem.; 32: 2119-22(Jul 1970).

The chemical effects of $^{132}Te \rightarrow {}^{132}I$ decay in ^{132}Te-labelled telluric acid and the subsequent thermal annealing of the ^{132}I-labeled recoil products were studied. Evidence is presented that the thermal annealing reactions proceed in part through defects generated in the recoil zone during the decay event itself. The internal conversion of the 53-keV transition in the $^{132}Te \rightarrow {}^{132}I$ decay appears to be important in this regard. (auth) (UK)

38987 STUDY OF CHEMICAL CHANGES DURING ELECTRON CAPTURE OF ^{125}Xe IN CERTAIN INORGANIC SYSTEMS. Kuzin, V. I.; Nefedov, V. D.; Norseev, Yu. V.; Toropova, M. A.; Khalkin, V. A.; Groz, P. Radiokhimiya; 12: 137-42(1970). (In Russian).

Interaction processes of atomic ions of ^{125}I, which are formed upon decomposition as a result of electron capture in ^{125}Xe in media of Xe, H_2, O_2, and water vapor, were studied. It was found that on decomposition of ^{125}Xe in $^{125}Xe-H_2$ and $^{125}Xe-H_2O$, practically all of the ^{125}I is in I^- form. The distribution of ^{125}I daughter atoms in an atmosphere of xenon at 2 to 3 atm is I_2 – 80%, I^- – 20%. Distribution in an atmosphere of oxygen is I^- – 80%, I_2 – 10%, IO_3^- – 10%. (tr-auth)

Separation Processes

Refer also to abstracts 38705, 38710, 38711, 38728, 38804, 38815, 38826, 38916, 39037, 39171, 39181, 39201, and 39235.

38988 (BNWL-1473) THE SAFEGUARDS VALUE OF CHEMICAL PLANT MEASUREMENTS RELATING TO BURNUP: YANKEE CORES V AND VI. Christensen, D. E.; Matsen, R. P.; Schneider, R. A.; Wolkenhauer, W. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 138p. Dep. CFSTI.

Data evaluation methods relating to the area of burnup data from spent nuclear fuels were applied to accountability data that result from the measurements of spent reactor cores at a chemical processing plant. It was determined that the methods are easily applied to accountability data and significant information of value to a safeguards program results from application of the evaluation methods. (auth)

38989 (DOCKET-50201-39) WEST VALLEY REPROCESSING PLANT. Head End Ventilation System. Final Safety Analysis Report, Suppl. 1. (Nuclear Fuel Services, Inc., West Valley, N. Y.). Jul 1970. 52p. Dep. CFSTI.

The Head End Ventilation System will serve the mechanical processing areas of the NFS Reprocessing Plant by increasing pressure differentials between normally occupied areas and contaminated areas, increasing the air flow through contaminated areas where contact maintenance is performed, supplying ventilation to the Master Slave Manipulator Repair Shop, and diverting the particulate contamination to a filter system that is designed for its effective removal. Filter performance, system specifications, maloperation, and accident conditions are discussed. (M.C.G.)

38990 (DOCKET-50201-40) WEST VALLEY REPROCESSING PLANT. Quarterly Report, April 1–June 30, 1970. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 24 Jul 1970. 12p. Dep. CFSTI.

Operation of the plant is reported. Processing operations, nuclear materials accountability, radioactive waste, environmental monitoring, and facility performance and modification are discussed. (M.C.G.)

38991 (DOCKET-50332-14) BARNWELL NUCLEAR FUEL PLANT. Applicant's Environmental Report. (Allied-Gulf Nu-

clear Services, Florham Park, N. J.). 7 Jul 1970. 49p. Dep. CFSTI.

The possible effects on the environment and on the ecology of the area and planned programs for studies of the local hydrology and of the environment are discussed. Topics covered include: plant description, environmental effects, alternatives to the proposed actions, extent to which any commitments of resources might be irreversible, and additional information. (M.C.G.)

38992 (DP-Report-290) DYNAMIC BEHAVIOR OF GASEOUS FISSION PRODUCTS IN CHARCOAL ADSORBER COLUMNS. Project DRAGON. Werner, L. (Atomic Energy Establishment, Winfrith (England)). Mar 1965. 40p. Dep. CFSTI.

The adsorption kinetics of xenon and krypton on activated charcoal at low temperatures were investigated. The diffusivity was determined and its influence upon breakthrough in adsorber columns shown. (auth)

38993 (DP-Report-293) PRELIMINARY STUDY OF THE GRIND-LEACH HEAD-END TREATMENT OF COATED PARTICLE FUEL. Project DRAGON. Lingjaerde, R. O.; Podo, L. (Atomic Energy Establishment, Winfrith (England)). Sep 1964. 29p. Dep. CFSTI.

The aim and basis for the Dragon fuel reprocessing assessment studies are broadly outlined. A high decontamination reprocessing cycle is considered with mechanical grinding–acid leaching as the head-end step. The reasons for choosing this particular approach are given. Results of preliminary laboratory experiments on grinding–leaching uranium/thorium dicarbide fuel particles coated with pyrocarbon or pyrocarbon/silicon carbide/pyrocarbon, are presented and discussed. A quantitative recovery of the uranium and thorium is achieved using pure nitric acid or fluorine catalyzed nitric acid depending on the chemical state of the fuel after decomposition during grinding and subsequent exposure. (auth)

38994 (NP-10872) METHODS OF HELIUM PURIFICATION. Project DRAGON. Romberg, E. (Atomic Energy Establishment, Winfrith (England)). Sep 1961. 33p. (DP-Report-52). Dep. CFSTI.

Detailed information, based on present knowledge of chemical, physico-chemical, pure physical, and mixed methods for the removal of the different chemical impurities expected in the reactor coolant, including the fission products xenon and krypton, is given. (auth)

38995 (PRNC-135, pp 427-30) CHROMATOGRAPHIC SEPARATION OF PROTACTINIUM FROM THORIUM: A ^{234m}Pa AND ^{234}Pa GENERATOR. Abrao, Alcidio (Instituto de Energia Atomica, Sao Paulo (Brazil)).

From Radiation and isotope technology in Latin American development.

The short lived natural radioisotopes ^{234m}Pa(1.18 min) and ^{234}Pa (6.67h), descendants from the 24 day ^{234}Th (UX1), are valuable for half-life and dead-time determination, disintegration and genetic related radioisotopes studies, and as tracers (^{234}Pa). Only a few papers have been published concerning the separation of ^{234m}Pa, since it requires a very fast procedure. No convenient fast technique has been published. The method outlined allows a convenient and fast separation of both ^{234m}Pa and ^{234}Pa from ^{234}Th. The method is extremely simple, requires no special reagents and permits the milking of these radioisotopes at any desired moment. The method is based on the sorption of ^{234}Th from a solution containing 0.3M HF on an alumina column, from where the radioprotactinium can be eluted when desired. ^{234}Th is strongly retained on the alumina and ^{234m}Pa and ^{234}Pa can be milked many times successively, by simple elution with 0.2-0.3M HF. ^{234}Th is directly separated from uranyl nitrate solution (100 g/l U_3O_8) having 0.3M HF, by percolation on an alumina column (2 ml Al_2O_3). After the sorption of ^{234}Th the generator is ready to furnish ^{234m}Pa that can be milked each 1 to 5 minutes (for the ^{234m}Pa growth) with 1 to 3ml of 0.2-0.3M HF. (auth)

38996 (PRNC-135, pp 440-50) CHROMATOGRAPHIC SEPARATION AND CONCENTRATION OF THORIUM AND RARE EARTHS FROM URANIUM USING ALUMINA-HYDROFLUORIC ACID. PREPARATION OF CARRIER-FREE RADIOTHORIUM AND CONTRIBUTION TO THE FISSION RARE EARTHS. Abrao, Alcidio (Instituto de Energia Atomica, Sao Paulo (Brazil)).

From Radiation and isotope technology in Latin American development.

A new procedure is described for the separation and concentration of thorium and rare earth elements (RE) from uranyl solutions. The method is based upon the sorption of Th and RE when an acid solution of uranyl nitrate, chloride or sulfate, containing 0.3m HF is percolated through a small column of alumina (Al_2O_3), the uranyl ion being not sorbed. This method allows Th and RE present at very low concentration in uranyl solutions to be separated and concentrated on alumina. The method is simple, fast, requires no special reagents, allows high ^{234}Th activity to be collected, and only a few milliliters of acid are necessary to remove the UX1 from the alumina. The UX1 prepared is radiochemically pure. Additional advantage is the re-use of the uranyl solutions after observing a period for the ^{234}Th ingrow. The method is also being used for the separation, concentration, and determination of ^{232}Th and total RE in uranium. Preliminary experiments using radioeuropium added to a uranyl nitrate solution demonstrated the availability of this technique for separating fission rare earths from irradiated uranium, with the additional advantage of alumina being quite resistant to radiation damage, unlike organic ion exchangers. The method can be used to separate and collect ^{230}Th (ionium) descendant from ^{238}U, and ^{231}Th and ^{227}Th, descendants from ^{235}U. Details on the flow rate, pH, U and HF concentration, capacity of Al_2O_3, and limitations of the method are given. (auth)

38997 (RISLEY-Trans-1895) CENTRIFUGAL EXTRACTORS FOR THE REPROCESSING OF NUCLEAR FUELS WITH HIGH BURN-UP AND PLUTONIUM CONTENT. Roth, B. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Translation of report KFK-862. 18p. Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 24: 16624.

38998 (RT/CHI-(69)19) KINETICS OF THE BACK WASHING OF PLUTONIUM WITH FERROUS SULFAMATE IN AN AMINE SYSTEM. Dworschak, H.; Barocas, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 24 Sep 1969. 45p. (In Italian). (EUR-4137). CFSTI (U. S. Sales Only).

The kinetics of Pu(IV) back washing from tertiary amines (TCA or Alamine 336) with ferrous sulfamate was studied. It was found to depend on the amine concentration, the nitric acid/nitrate concentration, and the stirring speed and/or the interfacial area in emulsified systems. A reaction at the interface must therefore be considered as the rate determining step. The back washing rates could be quantitatively related with the distribution coefficients of Pu(IV), as long as the species of Pu(IV) in both phases did not alter. The decisive influence of these kinetics on the results obtained in countercurrent experiments with small mixer-settlers was demonstrated. (auth)

38999 HIGH RESOLUTION PARTITION CAPILLARY COLUMNS. Liberti, A.; Zoccolillo, L. (Univ., Rome). J. Chromatogr.: 49: 18-20(20 May 1970).

Various procedures to obtain high resolution glass capillary columns are described. By roughening the glass surface either with a layer of carbon or with polymerized material, a stationary phase of any polarity can be successfully coated. Results obtained with Carbowax, trimer acid, and squalane columns are reported; the separation of polar and non-polar compounds from their deuterated homologs ($C_6H_5CD_3-C_6H_5CHD_2-C_6H_5CH_2D-C_7H_8$; $C_2H_5SO-C_2D_5SO$) is shown. (auth)

39000 THE USE OF HIGH EFFICIENCY PACKED COLUMNS FOR GAS-SOLID CHROMATOGRAPHY. II. THE SEMI-PREPARATIVE SEPARATION OF ISOTOPIC MIXTURES. Di Corcia, Antonio; Bruner, Fabrizio (Univ., Rome). J. Chromatogr.: 49: 139-45(20 May 1970).

High efficiency packed adsorption columns were prepared with graphitized carbon black as adsorption medium. The influence of carrier gas, column design, packing characteristics, sample retention and size on column efficiency was investigated. A HETP value of about 1 mm was obtained for the 120-m column with methane when 0.5 cc s.t.p. of methane is injected. The separation of CH_4 and CH_3D is shown using different column lengths. The R^2/t ratio for this separation is of an order of magnitude greater than that found in the literature up to date. The implications of these results for a preparative separation of isotopes are discussed. (auth)

39001 MOLECULAR-STATISTICAL CALCULATION OF THE THERMODYNAMIC CHARACTERISTICS FOR SEPARATION OF DEUTERATED MOLECULES BY ADSORPTION. Poshkus, D. P. (Inst. of Chemistry and Chemical Tech., Vilnyus, USSR). J. Chromatogr.: 49: 146-52(20 May 1970).

Calculations were made of the ratio of the retention volumes, the differences in the isosteric heats and differential entropies of adsorption for the pairs of the isotopic-substituted molecules CH_4-CD_4, $C_2H_6-C_2D_6$, $C_2H_4-C_2D_4$, $C_6H_6-C_6D_6$ and $C_6H_{12}-C_6D_{12}$ on graphitised carbon blacks. The differences in the potential functions of the interaction between the isotopic molecules and the adsorbent surface and the differences in the quantum effects for the vibrations of the isotopic molecules mass centres normal to the surface have been taken into account. The results of the calcula-

tions are compared with experimental data found in the literature. The differences in the quantum effects for the vibrations of the mass centres of the hydrocarbon isotopic molecules normal to the surface are small and only appreciable for the lightest molecules. The isotopic effect on adsorption of the hydrocarbon molecules on graphitised carbon blacks is mainly caused by the difference in the potential functions of the interactions of isotopic molecules with the surface. The zero point energy effect can also contribute to the isotopic effect for hydrocarbon molecules. (auth)

39002 SEPARATION OF MOLYBDENUM IN FISSION PRODUCTS BY SOLVENT EXTRACTION AND EXTRACTION CHROMATOGRAPHY. Yoshida, Hiroyuki; Yonezawa, Chushiro; Gunji, Katsubumi (Japan Atomic Energy Research Inst., Tokai). Jap. Anal.; 19: 818-23(Jun 1970). (In Japanese).

Methods are described for the separation of Mo in fission products by solvent extraction and extraction chromatography using α-benzoinoxime. Mo is extracted from an aqueous solution of 1 N HCl containing oxalic acid into 0.2% α-benzoinoxime in chloroform. The organic phase is washed with 1 N HCl containing oxalic acid and sodium bisulfite. In case of 99 Mo gamma-radioactivity is measured using an NaI(Tl) scintillation counter 18 hr after separation. The separation of Mo in fission products by extraction chromatography was studied also. The method was successfully applied to the determination of $^{235}U/^{238}U$ isotopic ratio by neutron activation analysis based on chemical separation of ^{99}Mo and ^{239}Np and also to the determination of burnup of irradiated nuclear fuel by isotope dilution mass spectrometry of Mo. (auth)

39003 THIN LAYER CHROMATOGRAPHY IN MIXED AQUEOUS ORGANIC SOLVENT. I. THE ACTINIDES IN THE SYSTEM HCl–ISOPROPANOL–WATER. Falk, Erika; Buchtela, K.; Grass, F. (Oesterreichische Hochschule, Vienna). Atomkernenergie; 15: 297-300(1970. (In German).

The actinides were separated using hydrochloric acid-water-isopropanol as a mobile phase on thin layer cellulose plates. All the possible daughter products and contaminations due to the production process were detected. The variation of the migration distance with the composition of the mobile phase was systematically studied. The relation between the order of the migration distance and the complex constants is discussed. (auth)

39004 PRECIPITATION OF ZIRCONIUM BY MEANS OF TARTRAZINE AND ITS SEPARATION FROM IRON, TITANIUM, ALUMINUM: AND RARE EARTHS. Kulumbegashvili, V. A.; Ostroumov, E. A. (Inst. of Oceanology, Moscow). Zh. Anal. Khim.; 25: 1112-17(Jun 1970). (In Russian).

Conditions have been studied for the complete precipitation of zirconium with tartrazine. The content of zirconium in its compound with tartrazine has been found and the possibility of determining zirconium by weighing this compound after drying has been confirmed. The separation of zirconium from Fe(III), Ti(IV), and Al(III) has been studied. The separation from titanium is possible in solutions of higher acidity (0.15 N). Zirconium can also be quantitatively separated from the cerium and yttrium groups of the rare earths. (auth)

39005 SEPARATION OF RARE EARTH IONS BY PRECIPITATION DURING ELECTROMIGRATION. Deman, Joris (Rijksuniversiteit, Ghent). Anal. Chem.; 42: 983-9(Aug 1970).

In this separation method, rare earth ions move through a gel column under the influence of a direct electric field. At a certain section of the column, they meet a region containing an ionic species that precipitates the rare earth ions. Because the precipitate remains at the section where it was actually formed, a precipitate region is established that extends to the side where rare earth ions and precipitating ion meet. The rare earth ions, while moving over the precipitate region, undergo exchange reactions. As a result, the ions separate in a manner analogous to that found in chromatography. The method is demonstrated with oxalate as the precipitating ion. Separation efficiency is measured with the aid of added radioactive isotopes. (auth)

39006 STUDIES OF COMPLEX EQUILIBRIA IN MOLTEN SALTS AND AQUEOUS SOLUTIONS BY RADIOACTIVE TRACER DISTRIBUTION METHODS. Liljenzin, J. O. Goteborg; Chalmers Univ. of Tech. (1969). 32p.

Thesis.

A new method for the determination of complex formation constants and distribution constants in molten salts was developed. The distribution of a radioactive tracer isotope between a melt and Al_2O_3 was measured, and the variation of the distribution ratio with ligand concentration was used to calculate the equilibrium constants. The method gave results in agreement with published data. It is predicted that the method could be used at very high temperatures. Liquid-liquid extraction techniques were used to study the formation and extraction of protactinium complexes with acetylacetone. Tetravelent Pr was produced by electrolytic reduction in a two-phase system. The continuous solvent extraction (AKUFVE) technique was improved and used with radioactive tracers to study the formation and extraction of the acetylacetone complexes of Cu^{2+}, Zn^{2+}, Np^{4+}, and Am^{3+}. This technique was used to study the formation of nonextractable tartrate and oxalate complexes of Cu^{2+}. From these experiments stability and distribution constants and thermodynamic functions were evaluated. Suitable computer programs were developed. (auth) (Sweden)

39007 CHEMICAL EXTRACTION OF AN ORGANIC MATERIAL FROM A URANIUM ORE. Jacobs, M. L.; Warren, C. G.; Granger, H. C. (Colorado State Univ., Fort Collins). U. S., Geol. Surv., Prof. Pap.; 700-B: 184-6(1970).

Organic material associated with uranium ore in the Ambrosia Lake mining district, New Mexico, is difficult to separate from inorganic contaminants by physical methods, is highly insoluble, and is nearly opaque to both the visible and infrared spectra. Thorough characterization of this organic matter by modern methods, however, must be preceded by purification and solution or volatilization without significant chemical changes. Tests were made in which the organic material was found to be virtually insoluble in 15 diverse solvents, although as much as 30% was extracted by dimethyl sulfoxide. The dimethyl sulfoxide-soluble fraction consisted of a uranium-rich organic material in one deposit and a uranium-molybdenum-rich organic material in the other deposit. Infrared absorption spectra indicated that the extracted material contains carboxyl functional groups. Data obtained from chemical studies and from the mass spectrometer, in addition to the infrared spectra, indicated that the extract contains an aromatic component. (auth)

39008 DI-N-BUTYL CARBAMOYLPHOSPHONATE AS AN EXTRACTANT OF INORGANIC IONS FROM HYDROCHLORIC ACID SOLUTIONS. Perricos, D. C.; Tsolis, A. K.; Belkas, E. P. (Democritus Nuclear Reactor Center, Athens). Talanta; 17: 551-2(Jun 1970).

The extraction of 33 elements by a 0.1M solution of di-n-butyl carbamoylphosphonate in chloroform was investigated as a function of hydrochloric acid concentration. The results show that this new extractant readily extracts most of the elements in a high oxidation state, including the trivalent rare earths, from hydrochloric acid at concentrations greater than 6M. (auth) (UK)

39009 ELECTROLYSIS OF MOLYBDENUM(VI) WITH MERCURY CATHODE IN THE PRESENCE OF NICKEL AND COBALT. Speranskaya, E. F.; Mertsalova, V. E.; Kiseleva, A. G. (Kazakh State Univ., Alma-Ata, USSR). Zh. Prikl. Khim.; 43: 896-8(Apr 1970). (In Russian).

It is shown that in the process of electrolysis of molybdenum (VI) with a mercury cathode in the presence of cobalt and nickel, complex Ni–Mo and Co–Mo amalgams are formed. The anode oxidation of the amalgams proceeds at negative values of the potential. The components of the amalgam on oxidation are isolated in alkaline solution simultaneously: cobalt and nickel in the form of hydroxides and molybdenum in the form of molybdate. (tr-auth)

39010 MEASUREMENT ON ADSORPTION OF SODIUM BY HAP WITH A Ge(Li) DETECTOR. Ishiyama, Toshio; Matsuda, Yatsuka; Mamuro, Tetsuo. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 24-6(1969).

Adsorption of Na by HAP (hydrated antimony pentoxide) was tested using a test liquid containing five kinds of radionuclides, ^{22}Na, ^{65}Zn, ^{60}Co, ^{144}Ce and ^{54}Mn, where activity measurements were made with a Ge(Li) detector. From the result of the experiment it was found that Na can be separated satisfactorily by the HAP column. (auth)

39011 ION EXCHANGE CHROMATOGRAPHY OF RARE EARTHS IN AQUEOUS ORGANIC MEDIA. VII. INFLUENCE OF ELECTROLYTES ON THE ION EXCHANGE CHROMATOGRAPHY OF RARE EARTHS. Alexa, J. (Inst. of Nuclear Research, Rez, Czech.). Collect. Czech. Chem. Commun.; 35: 1921-4 (Jun 1970).

The sorption and separation of rare earths in systems containing different normalities of some electrolytes and constant normality of complexing eluting agent were studied. The distribution coefficient of Ru, for example, decreased strongly with increasing normality of sodium ion in the system. Only a slight direct influence of inorganic electrolytes on the separation factor took place. (M.C.G.)

39012 SEPARATION OF RARE EARTHS. 14. SOLUBILITY SYSTEMS FOR ZINC NITRATE AND CERIC EARTH NITRATES. Brunisholz, G.; Klipfel, L. (Institut de Chimie Minerale et

Analytique, Lausanne, Switzerland). Rev. Chim. Miner.; 7: 349-58(1970). (In French).

Studies were made on the solubility of the double salts $2Ln(NO_3)_3-3Zn(NO_3)_2-24H_2O$ and also for $2Ln'(NO_3)_3-3Zn(NO_3)_2-2Ln''(NO_3)_3-3Zn(NO_3)_2-H_2O$ where Ln = rare earths. Isotherms of the solubilities were measured as parameters for eventual use in the separation of rare earths by crystallization of double salts. (P.C.H.)

39013 APPLICATION OF HIGH VOLTAGE ELECTROPHORESIS FOR THE SEPARATION OF RADIONUCLIDES. I. Buchtela, Karl (Oesterreichische Hochschule, Vienna). Atomkernenergie; 15: 293-6(1970). (In German).

High-voltage electrophoresis is very suitable for separation of radionuclides. Rapid separations and high decontamination factors are obtained and the interpretation of the results is not difficult. Short-lived radionuclides of the alkali metals are separated from neutron-irradiated uranium within 6 seconds. High decontamination factors are obtained by migration in different directions. Elements with similar properties (rare earths, americium, curium) can be separated with good results. Proposals are made to characterize electrophoretic separations dependent on time of the experiment and size of strips. The best experimental conditions for electrophoretic separation of rare earth elements were investigated. (auth)

39014 OPTIMIZATION OF THE AQUEOUS PROCESSING OF IRRADIATED FUEL FROM NUCLEAR POWER REACTORS. USE OF URANIUM(IV) NITRATE AS REDUCTANT IN A PUREX TYPE PROCESSING PLANT. Salomon, Louis; Lopez-Menchero, Emilio (Eurochemic, Mol, Belg.). Ind. Eng. Chem., Process Design Develop.; 9: 345-58(Jul 1970).

The conditions of the stability of U(IV) nitrate in aqueous and organic solutions are defined. The effects of temperature, acidity, atmosphere, nitrate concentration, radiolysis, and catalysis on the reoxidation of solutions with or without hydrazine nitrate as the stabilizing agent were studied. Under the process conditions studied, some distribution coefficients of U(IV), Pu(IV), and Pu(III) between aqueous nitrate and 30% TBP–Shell-Sol-T solutions are reported, and the kinetics of Pu(IV) reduction by U(IV) in both aqueous and organic phases are described. The best conditions for the use of U(IV) as plutonium reductant in the U/Pu partition cycle of the Purex process leading to a sufficient decontamination factor were optimized in mixer-settler runs with HSP (hydrazine-stabilized Purex) solutions at various Pu concentrations. The solvent degradation effect on the process was checked, with cobalt 60 gamma-irradiated solutions and with an HSP solution originated in the plant. The risks of reoxidation in the airlifts were also considered. The required uranium final product decontamination is easily obtained when the residual Pu from the first cycle is reduced by U(IV) in the second uranium cycle. The problem of isotopic dilution is discussed. (41 references.) (auth)

39015 ION EXCHANGE PROPERTIES OF AMORPHOUS TITANIUM PHOSPHATE. EXCHANGE EQUILIBRIUM WITH ALKALI METAL CATIONS. Dubos, Daniel; Kikindai, Tivadar (CEN de Saclay, Gif-sur-Yvette, France. Ecole Centrale des Arts et Manufactures, Chatenay-Malabry, France). Compt. Rend., Ser. C; 270: 1833-6(8 Jun 1970). (In French).

Ion exchange equilibrium of amorphous titanium phosphate with alkali metal cations in 0.1 N solutions is studied. The increasing selectivity is found to correspond to the decreasing hydrated ionic radii. The variation of the selectivity coefficient with the amount of cation fixed is studied and an inversion in the selectivity is pointed out. The values of the thermodynamical equilibrium constant are given. (France)

39016 INDUSTRIAL WASTES: RADIOACTIVE. J. Water Pollut. Contr. Fed.; 40: 1199-1219(Jun 1968).

Developments in the disposal of radioactive industrial wastes during 1967 are reviewed. Topics treated include special reports and books, waste treatment and disposal, water supply, chemical precipitation, solvent extraction, ground and ocean disposal. (275 references.) (J.G.B.)

39017 APPARATUS FOR THE CHROMATOGRAPHIC SEPARATION OF ELEMENTS WITH HIGH RADIOACTIVITY. Lebedev, N. A.; Tolstoi, N. S. Radiokhimiya; 12: 112-19(1970). (In Russian).

A remote control apparatus was designed for the chromatographic separation of rare earth elements of high radioactivity. The design of equipment for the transport and measurement of the radioactive elements and the collection of drops of eluent is given. Specifications are given for power control. (R.V.J.)

39018 SOLVATION OF SCANDIUM NITRATE WITH ETHYLENE BIS(DIOCTYLPHOSPHINE OXIDE). Smirnov, V. F.; Nikonov, V. I. Radiokhimiya; 12: 85-9(1970). (In Russian).

It was established that the coefficient of the distribution of scandium during the extraction from nitrate solutions is directly proportional to the concentration of ethylenebis(dioctylphosphine oxide) in the organic phase and inversely proportional to the concentration of hydrogen ions in the aqueous phase. The mechanism of the extraction was determined. (tr-auth)

39019 STUDIES ON MIXED HYDROXYACETATOURANYL COMPOUNDS IN AQUEOUS ACETATE–NITRATE SOLUTIONS. Nikol'skii, B. P.; Kolychev, V. B. Radiokhimiya; 12: 89-96(1970). (In Russian).

An anion exchange method was applied to the separation of uranium(IV). It was found that in acetate solutions a mixed hydroxyacetatouranyl complex is formed in addition to the saturated acetate complex of uranium. Its probable composition is $[UO_2Ac_2(OH)_2]^{2-}$. The equilibrium constant was calculated for the reaction: $[UO_2Ac_3]^- + 2(OH)^- \rightleftharpoons [UO_2Ac_2(OH)_2]^{2-} + Ac$ ($\mu = .05$; $t = 20°C$). (tr-auth)

39020 EXTRACTION OF NITRIC ACID AND ZIRCONIUM BY TRIBUTYL PHOSPHATE IN THE PRESENCE OF LITHIUM CHLORIDE. Apraksin, I. A.; Korovin, S. S.; Reznik, A. M.; Rozen, A. M. Radiokhimiya; 12: 17-22(1970). (In Russian).

The distribution of HNO_3 between aqueous solutions and TBP was studied in the presence of LiCl. It was found that LiCl is a stronger salting out agent than HCl. This was confirmed by determining the activity coefficients for HNO_3 in the presence of LiCl. It was found that zirconium is extracted by TBP from a mixture of $LiCl-HNO_3$ in the form of mixed chloride nitrate complexes with the composition, $Zr(NO_3)_iCl_{4-i} \cdot 2TBP$. (tr-auth)

39021 STUDY OF RATE OF EXTRACTION IN SYSTEMS WITH TRIBUTYL PHOSPHATE. II. THE EXTRACTION OF $UO_2(NO_3)_2$. Pushlenkov, M. F.; Shchepetil'nikov, N. N. Radiokhimiya; 12: 23-33(1970). (In Russian).

The rate of extraction of uranyl nitrate in the system, $UO_2(NO_3)_2-HNO_3-H_2O-(C_4H_9O)_3PO$ was studied. The effects of concentration of components, intensity of stirring, temperature, and the type of diluent are discussed. The first order reaction for uranium was established. It was found that when the extraction of uranium and nitric acid is combined, the HNO_3 reacts before the uranium. The re-extraction of excess acid takes place along with the extraction of $UO_2(NO_3)_2$. The accompanying transition processes of HNO_3 and H_2O do not affect the rate constants for the extraction of uranium. It was found that rate constants for the extraction of uranyl nitrate increase significantly with an increase in temperature. Rate constants for the extraction of uranyl nitrate using TBP increase in the following order: $CCl_4 < ClC_2H_4Cl < CHCl_3$. Energies of activation decrease in the same order. (tr-auth)

39022 EXTRACTION OF COMPLEX ACIDS BY OXYGEN-CONTAINING SOLVENTS. XIII. EXTRACTION OF POLONIUM(II AND IV) FROM SOLUTIONS OF HYDRIODIC ACID. Iofa, B. Z.; Yushchenko, A. S. Radiokhimiya; 12: 65-9(1970). (In Russian).

The extraction of polonium (II and IV) from solutions of hydriodic acid by 1-hexanol, 4-heptanone, pentyl acetate, and butyl ether. A mechanism for the extraction of Po using oxygen-containing solvents is proposed. Constants for the formation of the higher iodide complexes of Po were determined. (tr-auth)

39023 NMR STUDIES ON THE EXTRACTION OF URANIUM USING PHOSPHOORGANIC COMPOUNDS. I. INFLUENCE OF SOLVATION. Rozen, A. M.; Borodin, P. M.; Nikolotova, Z. I.; Sventitskii, E. N.; Chizhik, V. I. Radiokhimiya; 12: 69-76(1970). (In Russian).

Chemical shifts in TBP–TOPO and their solvates with uranyl nitrate were studied in order to better understand the characteristics of the extraction capability of neutral phosphoorganic compounds. Information was also obtained on structural effects during the dissolution of the extractants and their solvates in organic diluents (hexane, benzene, carbon tetrachloride, and chloroform). (R.V.J.)

39024 BENZYLPHENYLARSINIC ACID AS EXTRACTANT FOR Zr(IV) AND Hf(IV). Fouche, K. F.; Lessing, J. G. V. (Univ. of the Orange Free State, Bloemfontein, South Africa). J. Inorg. Nucl. Chem.; 32: 2357-67(Jul 1970).

The extraction of zirconium and hafnium from 1M $HClO_4$ solutions by benzylphenylarsinic acid (HBPA) in chloroform was studied as a function of the concentrations of HBPA, acid, thiocyanate ion, and perchlorate ion. In the absence of thiocyanate, the distribution coefficients of zirconium and hafnium are proportional to the fifth power of the equilibrium concentration of HBPA in the aqueous phase and are dependent on the perchlorate concentration. Thiocyanate has a synergistic effect on the extrac-

tion of both elements. Extractions from 1M $HClO_4$ + 0.1M NH_4CNS solutions have a third power dependence on the equilibrium HBPA concentration in the aqueous phase and a first power dependence on the thiocyanate concentration. Acid dependency studies are complicated by the protonation of the reagent (protonation constant, $pK_b = 0.58$). The relation between the distribution constant of HBPA and the total HBPA concentration in the system shows that the reagent molecules are associated in chloroform solutions. (auth) (UK)

39025 EXTRACTION OF THORIUM FROM HYDROCHLORIC ACID SOLUTIONS BY DI-(2-ETHYLHEXYL)-PHOSPHORIC ACID. Sato, Taichi (Shizuoka Univ., Hamamatsu, Japan). Z. Anorg. Allg. Chem.; 358: 296-304(May 1968).

The partition of thorium between hydrochloric acid solutions and solutions of di-(2-ethylhexyl)-phosphoric acid (DEHPA) in kerosene was investigated, and the mechanism of the extraction is discussed. The effect of organic solvent on extraction was also examined. (auth)

39026 STUDIES ON THE UPTAKE OF URANIUM(VI) ON SILICA GEL. Zaki, M. R.; Abd-El-Moneim, I. (Atomic Energy Establishment, Inshas, Egypt). Z. Anorg. Allg. Chem.; 360: 208-12(Jul 1968).

The uptake of U^{VI} from hydrochloric acid solutions on five extra-pure silica samples was studied in function of acidity, time of contact, and temperature of solution. The uptake was found to be affected by the characteristics of the sample. Mechanisms of uptake are discussed. The effect of uranium concentration on uptake was also studied and the results were found to obey the Langmuir isotherm. (auth)

39027 GAS CHROMATOGRAPHIC DETERMINATION OF PARTITION COEFFICIENTS OF SOME UNSATURATED HYDROCARBONS AND THEIR DEUTERATED ISOMERS IN AQUEOUS SILVER SOLUTIONS. Wasik, S. P.; Tsang, W. (National Bureau of Standards, Washington, D. C.). J. Phys. Chem.; 74: 2970-6(23 Jul 1970).

Experiments using aqueous solutions of silver nitrate as a gas chromatographic liquid phase were carried out. Stability constants for the reaction, $(Ag^+)_{aq}$ + $(Hydrocarbon)_{aq}$ ⇌ $(Ag \cdot Hydrocarbon)_{aq}$, where $(Hydrocarbon)_{aq}$ are various light olefins, aromatics, or some of their deuterated isomers were determined. For the olefins these values are in quantitative agreement with those obtained from conventional static techniques. In the case of ethylene $\Delta H = -23$ kJ/mol and $\Delta S = -38$ J/mol deg. The isotope effect for the solubility of benzene-d_6 (compared to the lighest isomer) in water is 1.05. Aqueous silver nitrate columns should also have interesting analytical applications, particularly in the field of isotopic separations. They appear to be more efficient than the conventional ethylene glycol–silver nitrate columns. (auth)

39028 ISOTOPE EFFECT OF THERMAL DIFFUSION IN SOME PURE MOLTEN SALTS. Andreasson, Dan; Lunden, Arnold (Chalmers Univ. of Tech., Goteborg). Z. Naturforsch.; 25a: 793-4(May 1970).

The heat of transport for isotopes of the cations was determined for the following molten salts: KCl (78 cal/mole), KBr (46 cal/mole), KSCN (52 cal/mole), RbCl (92 cal/mole), and RbBr (49 cal/mole). Thus, the heat of transport is roughly the same for corresponding potassium and rubidium salts, and it is considerably higher for a chloride than for the other ones. In these two aspects the isotope effect of thermal diffusion behaves differently from that of electromigration in molten salts. (auth)

39029 METHOD OF FLUORINATION OF A MATERIAL CONTAINING URANIUM AND PLUTONIUM. (to Centre d'Etude de l'Energie Nucleaire). British Patent 1,198,525. 15 Jul 1970. Priority date 6 Sep 1966, Luxembourg.

A method for fluorinating a nuclear fuel to effect separation of Pu and U from the fuel comprises subjecting the material to a mixture of reagents made up of ClF_3 with Cl_2 and/or ClF to form volatile UF_6 and nonvolatile PuF_4 to separate UF_6 from the PuF_4. The reaction temperature may be 25 to 700°C. (B.L.M.)

39030 METHOD FOR REPROCESSING NUCLEAR FUEL. (to Centre d'Etude de l'Energie Nucleaire). British Patent 1,198,454. 15 Jul 1970. Priority date 6 Sep 1966, Luxembourg.

A method for reprocessing solid material containing Pu and U and comprising or derived from nuclear fuel comprises subjecting the material to the action of ClF at a temperature <700°C so as to form volatile UF_6 and solid PuF_4. The UF_6 is separated from the PuF_4 and condensed, at least in part, with Cl_2 formed by the reaction. Excess ClF is not condensed with the UF_6 and is recycled. (B.L.M.)

39031 RESULTS OF SYSTEMATIC INVESTIGATIONS OF EXTRACTION OF NITRATES OF RARE EARTHS, THORIUM, AND URANIUM BY UNDILUTED TRIBUTYL PHOSPHATE. Nikolaev, A. V.; Ryabinin, A. I.; Afanas'ev, Yu. A. Radiokhimiya; 12: 326-35(1970). (In Russian).

Extractions of rare earths, thorium, and uranium from nitrate solutions by TBP were studied. The reciprocal effects of the elements on the extraction process for each were determined. Uranium and cerium decreased the extraction of thorium. Thorium had almost no effect on the extraction of cerium, but had a significant effect on the extraction of uranium. Uranium had less effect on the extraction of cerium than cerium had on uranium. (R.V.J.)

39032 EXTRACTION OF MICROQUANTITIES OF YTTRIUM BY DI-p-CRESYL PHOSPHATE. Fomin, V. V.; Potapova, S. A. Radiokhimiya; 12: 318-26(1970). (In Russian).

The extraction of very small quantities of yttrium from nitrate solutions by di-p-cresyl phosphate was studied. The extracted compound has the composition $Y(HA_2)_3$. Comparative data on the extraction of yttrium by compounds of the type $(RO)_2POOH$ are given. (tr-auth)

39033 INVESTIGATION OF PROMETHIUM COMPLEX FORMATION. Brezhneva, N. E.; Levin, V. I.; Ratnikova, M. G.; Novoselov, V. S. Radiokhimiya; 12: 259-65(1970). (In Russian).

The distribution of promethium-147 between chloroform solutions of 8-quinolinol and 0.1N solutions of $NaClO_4$ at different pH values was studied. The stability constants of complexes of promethium with 8-quinolinol were determined. The graphic method and the method of least squares were used in the calculations. (tr-auth)

39034 PARTITION OF FLUOROCATIONS OF SCANDIUM, YTTRIUM, LANTHANUM, AMERICIUM(III), AND CURIUM(III) BETWEEN A CATION-EXCHANGER AND AN AQUEOUS SOLUTION. Aziz, A.; Lyle, S. J. (Univ. of Kent, Canterbury, Eng.). J. Inorg. Nucl. Chem.; 32: 2383-7(Jul 1970).

A study was made of the distribution coefficients l_0, l_1 and l_2 in that order for M^{3+}_{aq}, MF^{2+}_{aq}, and MF^{+}_{2aq} between Zeo-Karb-225 cation exchanger and an aqueous sodium perchlorate solution of ionic strength 0.500 at 25°C. For scandium $l_0 > l_1 > l_2$, but for yttrium, lanthanum, americium (III), and curium(III) the order is $l_0 > l_2 > l_1$. (auth) (UK)

39035 REPROCESSING OF URANIUM–PLUTONIUM NUCLEAR FUELS. Baumgaertner, F. (Kernforschungszentrum, Karlsruhe, Ger. Univ., Heidelberg); Philipp, H. Fortschr. Chem. Forsch.; 12: 712-74(1969). (In German).

Topics covered include: the historical development of fuel reprocessing methods, chemistry of the Purex Process, technical methods, development problems in aqueous reprocessing, and production of battery nuclides. (216 references) (M.C.G.)

39036 ADSORPTION PROPERTY OF NITROSYLRUTHENIUM COMPLEX ON ACTIVATED CARBON. Matsumura, Takashi; Ishiyama, Toshio (Radiation Center, Osaka). Radioisotopes (Tokyo); 19: 326-7(Jul 1970).

The possibility of using activated carbon in the decontamination of radioactive Ru in the treatment of radioactive waste water was examined. Adsorption properties were investigated through the batch equilibrium method at room temperature. The results showed that nitronitrosyl or nitritonitrosyl ruthenium complex was completely removed by the addition of 500 or 700 ppM of the activated C, respectively. Thus, it was concluded that activated C is an excellent adsorber for the removal of nitrosyl ruthenium complexes from radioactive waste water. (P.C.H.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 38991, 39141, 39254, 39376, 39380–39382, and 40577.

39037 (DOCKET-50201-36) WEST VALLEY REPROCESSING PLANT. Site Environmental Studies. (Dames and Moore, New York). 22 Jul 1970. 56p. Dep. CFSTI.

For Nuclear Fuel Services, Inc., West Valley, N. Y.

Seismo-tectonic studies were made for the proposed expansion of an existing nuclear spent fuels reprocessing facility at West Valley, New York. Regional and local geology are considered, along with historical earthquake activity, the relation of seismic activity to known or suspected geologic structure and mechanisms. (M.C.G.)

39038 (ORNL-4446, pp 1-8) FATE OF TRACE ELEMENTS AND RADIONUCLIDES IN TERRESTRIAL ENVIRONMENT. Tamura, Tsuneo; Bonner, W. P.; Francis, C. W.; Brinkley, F. S.; Eastwood, E. R. (Oak Ridge National Lab., Tenn.).

Zonal centrifugation techniques are described for analysis of clay and bottom sediments. The studies are primarily concerned with an improved mineral identification technique and increased understanding of environmental systems, with particular reference to phosphate distribution in the pond. The property of different densities of clay minerals was used for identification of clay minerals. A figure is presented to show smoothed x-ray diffraction tracings of magnesium-saturated glycerol-solvated clays from recovered bands. Phosphorus-32 distribution in soils and sediments was studied and effects of calcium carbonate on forms of phosphate in soil and sediment are shown by a table. Studies on the ORIC pond revealed that there was a significant decrease in phosphate since 1966 and organic nitrogen appeared to increase. Data showed that nutrients in the pond were being depleted and it is suggested that the minimal algal growths observed during 1968 could have resulted from the decrease in the concentration of phosphate. (H.L.W.)

39039 (PRNC-135, pp 269-86) SEDIMENTATION SURVEY OF LAKE GUAYABAL, PUERTO RICO USING A NUCLEAR SEDIMENT DENSITY PROBE. McHenry, J. Roger; Hawks, Paul H. (Department of Agriculture, Oxford, Miss. Sedimentation Lab.).

From Radiation and isotope technology in Latin American development.

Densities of sediments in Lake Guayabal, P. R., were measured in-place with a nuclear sediment density probe as part of a broader program, in cooperation with the U. S. Bureau of Reclamation and the Puerto Rico Water Resources Authority, to evaluate the water supply of the South Coast Irrigation District. The gamma probe uses radium as a source of gamma rays. The attenuation of the scattered and reflected gamma rays is a function of the density of the medium surrounding the probe. An empirically determined calibration curve was used to convert the radiation intensity readings to density values. Measurements of sediment densities in-place were made with an error of less than 0.5 lb/ft^3. The design, construction, and operation of the gamma probe are described, as well as the survey and results from the Lake Guayabal study. (auth)

39040 (PRNC-135, pp 295-306) STUDY OF SEDIMENT MOVEMENTS IN THE PLATA RIVER WITH RADIOACTIVE TRACERS. Gomez Ruiz, Hector R.; Baro, Gregorio B.; Garcia Agudo, Edmundo (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). (In Spanish).

From Radiation and isotope technology in Latin American development.

The study of sediment transportation by means of radioactive tracers was carried out in three areas of the Plata River, by labeling it with ^{110}Ag and measuring its displacement with in situ detection equipment. This work was part of a feasibility study for the construction of a channel between the entrance to the Panamá de las Palmas and Puerto Nuevo Rivers. The data gathered have also been used to compare a reduced model of the Plata River with a moving bed. Previous studies for selecting the tracer and the labeling method most convenient to the characteristics of the sediment in the river bed and the labeling of more than 300 kg of sediments from the three points selected to be treated with this material in the Plata River are also described. Details are also given on the labeling and injection operations, as well as measuring the radioactive tracer whose displacement was observed for over a year. The operations used and the convenience of the techniques employed are analyzed. (auth)

39041 (PRNC-135, pp 307-16) RADIOACTIVE TRACERS APPLIED TO THE STUDIES OF SEDIMENT TRANSPORTATION. Maestrini, A. A.; Aun, P. E.; Castro, J. O. N. M.; Rozental, J. J.; Machado, O. V. E. (Minas Gerais Univ., Belo Horizonte (Brazil). Instituto de Pesquisas Radioativas).

From Radiation and isotope technology in Latin American development.

A Brazilian study of sediment transportation using radioactive tracers is presented. Tests were performed in the port of Rio de Janeiro, to learn whether material dredged and deposited in the disposal areas returned to the navigation channel that allows the access to the port. Sand and silt samples were labeled with ^{198}Au. The transportation of the labeled material was followed during the next 4 days after the injection. Computer analysis of the obtained data verified that the dredged material was returning to the navigation channel. (auth)

39042 (PRNC-135, pp 317-26) FLOW RATE MEASUREMENT OF RIVERS AND TURBINES USING RADIOISOTOPES. Aun, P. E.; Ferreira, O. C.; Maestrini, A. A.; Castro, J. O. N. M.; Machado, O. V. B.; Aun, L. R. (Minas Gerais Univ., Belo Horizonte (Brazil). Instituto de Pesquisas Radioativas).

From Radiation and isotope technology in Latin American development.

Radioactive isotopes have been used, frequently, in flow rate measurements; in certain cases they present some advantages in relation to the conventional methods. Thus, the radioisotopes are used in the calibration of measuring instruments and in the determination of flow rates in large size pressure pipings. The application of radioisotope methods in rivers presents greater technical difficulties, and this work program aims to apply them to flow rates up to 1,000 m^3/s. The techniques that have been used in flow rate measurements in rivers and in pipes are described. (auth)

39043 (PRNC-135, pp 353-7) LOCATING LEAKS IN AN ANTIACID DRAIN WITH RADIOISOTOPES. Gomez Ruiz, Hector R.; Eroles, Manuel I. L. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). (In Spanish).

From Radiation and isotope technology in Latin American development.

A method for locating leaks in an antiacid subterraneous drain of an ironworks plant by using radioactive tracers is described. The depth of the drain (8m), the amount of liquid flow (2 to $3 m^3/sec.$), and the operating conditions in the plant required a change in conventional tracer techniques. The new method consisted of drilling holes close to the pipe, 9m deep and 40mm in diameter, 22mm apart in the area where the leak or leaks were presumed to exist. In the bottom of the holes, a resin with ionic interchange was placed in order to determine the ^{131}I used as tracer. When the activity in the different resins employed was measured, an important leak was precisely located. (auth)

39044 LEAD AND URANIUM IN PENNSYLVANIA ANTHRACITE. Chow, T. J.; Earl, J. L. (Univ. of California, La Jolla). Chem. Geol.; 6: No. 1, 43-9(May 1970).

Lead concentration, its isotopic composition, and the uranium content of Pennsylvanian anthracites were determined. From the isotopic analysis, it was interpreted that common lead was incorporated into the ancient, bedded plant material in Carboniferous times prior to coalification, while the uranium was introduced into the anthracite after coalification. (auth)

39045 NUCLEAR METHODS APPLIED TO URANIUM GEOCHEMISTRY. Rosholt, J. N. (US Geological Survey, Denver). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 173-6(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Stable and radioactive daughter products produced from nuclear disintegrations of uranium have proved useful in fundamental studies of the geochemistry of uranium in igneous rock and sedimentary environments and in ore deposits. Information gained from geochemical studies of uranium migration has been used to develop models for attempts to date archeological, geological, and oceanographic environments represented by samples of bone, wood, charcoal, continental and marine carbonates, marine sediments, and glacially derived soils. Recent improvements of nuclear instrumentation and techniques allowed accurate measure-

ments of natural radioactive isotopes, and it is now believed that radioactive equilibrium between the long-lived isotopes of the two uranium decay series is more the exception than the rule in nature. It was assumed that the ^{234}U and ^{238}U isotopes were in equilibrium until Thurber confirmed that considerable separation between ^{234}U daughter and ^{238}U parent exists in nature. It now has been documented that the ^{234}U content may range from 60% deficient to 500% in excess relative to ^{238}U. An excess of 15% of ^{234}U isotope in sea water is well documented. A summary of previous work has shown that geochemical fractionation of the radioactive nuclides in ^{238}U and ^{235}U decay series takes place in the hydrologic environment, resulting in depletion of ^{230}Th and ^{231}Pa with respect to their parents, ^{238}U, ^{234}U, and ^{235}U, in water and a complementary enrichment of these daughter nuclides in some sediments. Subsequent assimilation of uranium, essentially free of radioactive daughters, occurs in some specific types of deposits such as carbonates and phosphates. In the study of the geochemical processes involved in the migration of uranium and its isotopes (^{234}U, ^{235}U, ^{238}U) in the hydrologic cycle, radioactive tracers produced by nuclear processes in nature (^{230}Th as tracer of ^{234}U and ^{231}Pa as tracer of ^{235}U and ^{238}U) have proved useful in studies of the Pleistocene. This tracer technique is a powerful tool when applied to pleistocene chronology, and possibly to the correlation of glacial deposits in their respective stages of glacial deposition. Natural tracer studies have been initiated to investigate the process of uranium removal from Precambrian granitic rocks by comparison of the concentrations of radiogenic lead isotopes (^{208}Pb, ^{207}Pb, ^{206}Pb) to the concentrations of uranium and thorium in total rock samples. Initial results indicate that large volumes of uranium have been removed from the Granite Mountains in Wyoming and may have provided a major source for the uranium deposits in the central Wyoming basins. (auth)

Meteorology

Refer also to abstracts 38991, 39256, and 39897.

39046 (BNWL-1307(Pt.1)) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT FOR 1969 TO THE USAEC DIVISION OF BIOLOGY AND MEDICINE. VOLUME II. PHYSICAL SCIENCES. PART 1. ATMOSPHERIC SCIENCES. Simpson, C. L.; (and others) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 148p. Dep. CFSTI.

Thirty-one articles are included; separate abstracts were prepared for each. (P.C.H.)

For abstracts of individual papers see: 39047–39077.

39047 (BNWL-1307(Pt.1), pp 2-6) EFFECTS OF SOURCE HEIGHT AND STABILITY ON PLUME CENTERLINE EXPOSURE. Nickola, P. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

Nine field tracer releases were made at Hanford from an elevation of 365 ft during 1969. Plume centerline exposures resulting from these releases were compared with centerline exposures from previous releases from heights between 23 and 185 ft. The results are presented in the form of graphs of exposure versus travel time and exposure versus distance from source. Releases were primarily under stable atmospheric conditions. (auth)

39048 (BNWL-1307(Pt.1), pp 6-10) REAL TIME HISTORIES OF DIFFUSING PLUMES AND PUFFS DETERMINED FROM USE OF AN INERT GAS TRACER SYSTEM. Nickola, P. W.; Ramsdell, J. V. Jr.; Ludwick, J. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

A brief description is given of the Hanford inert gas tracer system employed in atmospheric diffusion studies. Some example results of computer processed field data are presented. The example concentration versus time measurements for a number of field locations result from a 20-min continuous tracer release (plume) and an instantaneous point release (puff). (auth)

39049 (BNWL-1307(Pt.1), pp 10-14) MEASUREMENTS OF THE TRANSPORT SPEED AND PHYSICAL DIMENSIONS OF A DIFFUSING PUFF OF A GASEOUS TRACER IN THE ATMOSPHERE. Nickola, P. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

Measurements of puff dimensions and transport speed were obtained from five inert gas tracer releases. The speed of transport was found to increase with distance from the source, and the speed was found (in all but one case) to correspond to wind speeds measured at heights between tracer release and sampling heights. Puff dimensions were greater in the downwind direction (length) than in the crosswind direction (width) in all cases. In unstable atmospheres, the ratio of puff length to puff width decreased as the puff moved from 200 to 800 m from the source. However, in more stable atmospheres, the ratio of puff length to width increased during the 200 to 800 m transport period. (auth)

39050 (BNWL-1307(Pt.1), pp 15-18) SHORT PERIOD ATMOSPHERIC CONCENTRATIONS RESULTING FROM NEAR GROUND LEVEL TRACER RELEASES OVER ROUGH TERRAIN. Nickola, P. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

Real-time measurements were made of atmospheric concentration of a tracer released over a marine terrace in southern California. Tracer was released continuously over periods of thirty minutes. The maximum short period (5 sec) concentration observed near plume centerline was as much as 14 times the value of the 30-min mean concentration observed at the plume centerline. The maximum short-period-to-mean-centerline concentration ratio was found to decrease with increasing distance from the centerline. Distributions of short period concentrations contributing to mean concentration are given for several different locations within a diffusing plume. (auth)

39051 (BNWL-1307(Pt.1), pp 19-20) TERRAIN INFLUENCE ON ATMOSPHERIC DIFFUSION. Hinds, W. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

Continued analysis of diffusion data obtained during Operation Mountain Iron led to significant conclusions. The relation between time and distance regression was found to lead to a prediction of relations between meteorological variabilities that was verified, thus assuring the reality of the two regressions. Evidence that rough terrain decouples diffusion from source point meteorological conditions is given. The feasibility of using Lagrangian techniques in operational analyses is discussed. (auth)

39052 (BNWL-1307(Pt.1), pp 21-5) MODELING PEAK-TO-MEAN CONCENTRATION RATIOS IN DIFFUSING PLUMES. Ramsdell, J. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

A mathematical model for estimating peak-to-mean concentration ratios in diffusing plumes has been developed using linear least squares regression techniques. (auth)

39053 (BNWL-1307(Pt.1), pp 25-6) PEAK-TO-MEAN CONCENTRATION RATIOS IN BUILDING WAKES. Hinds, W. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

Results from a short but unique series of tests of diffusion from a point source located just upward of an obstacle are described. It was found that diffusion in a wake is quite similar to bimodal plumes from an unobstructed point source, and that there was no important difference in peak-to-mean ratios between point source plumes and building wakes, if both sources are near ground level. (auth)

39054 (BNWL-1307(Pt.1), pp 27-9) CONCENTRATION FLUCTUATIONS IN DIFFUSING PLUMES. Ramsdell, J. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

Concentration fluctuations in diffusing plumes were examined through cumulative frequency distributions of short-term concentration measurements and the intensity of the concentration fluctuations. Concentration intermittency and the intensity of fluctuations were larger than expected. Both cumulative frequency distributions and the intensity of fluctuations were a function of crosswind position in the mean plume. (auth)

39055 (BNWL-1307(Pt.1), pp 29-34) MESOSCALE STUDIES AT HANFORD. Daubek, H. G.; Wolf, M. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

Wind velocity summaries at several sites on the Hanford reservation, streamline analysis, and the tracking of tetroons and pibals were used to identify mesoscale anomalies in the airflow which preclude the use of single-site data in the accurate defini-

tion of the trajectory and diffusion of pollutants on the reservation. (auth)

39056 (BNWL-1307(Pt.1), pp 36-41) TURBULENCE STUDIES IN THE ATMOSPHERIC BOUNDARY LAYER. Horst, T. W.; Elderkin, C. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

Five, 35-min periods were selected for analysis from 18 hr of micrometeorological data recorded during 1969. Necessary steps are outlined for obtaining the surface Reynolds stress from cup anemometer wind profiles taken over terrain requiring a zero-plane displacement correction. Directly measured values of the Reynolds stress at 16 m and 58 m were combined with the profile derived stress at 4 m to obtain a vertical gradient of momentum transport. This gradient was found to agree with estimates obtained from the averaged equation of motion in the direction of the mean wind except for the case of maximum thermal instability. Here the 35-min period was found to sample inadequately the lower frequency contributions to the Reynolds stress. (auth)

39057 (BNWL-1307(Pt.1), pp 36-41) AIRCRAFT INSTRUMENTATION FOR BOUNDARY LAYER METEOROLOGICAL STUDIES. Gladfelder, F. O.; Elderkin, C. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

A single engine (Cessna 305A) aircraft has been instrumented to record temperature, humidity, altitude, and air speed in support of boundary layer studies at Hanford. (auth)

39058 (BNWL-1307(Pt.1), pp 46-53) DEVELOPMENT AND TESTING OF A STABLE BUOY AND INSTRUMENT SYSTEM FOR STUDIES AT THE SEA-AIR INTERFACE. Woodruff, R. K.; Dunbar, A. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

The fluxes of momentum, heat, and moisture at the sea-air interface affect atmospheric processes on many scales. These processes control the transport and deposition of radionuclides. In 1969, Battelle-Northwest joined Florida State University in preparation and operation of the FSU TRITON buoy system during BOMEX for measuring mean meteorological and oceanographic parameters and the turbulent eddy fluxes of momentum, heat, and moisture. These measurements can be used with profiles of radionuclide concentration to estimate deposition, and for the investigation of other basic sea-air interaction processes. The power requirement of the turbulence system resulted in the development of a unique thermoelectric generator power supply. During the BOMEX, the power supply was demonstrated to be applicable and functional. Difficulties, related to the initial incompatibility of the added turbulence data acquisition system, resulted in a limited amount of turbulence data. After some modification, the data system operated reliably as an independent system during a subsequent shore-based study. Although the TRITON system was not fully integrated with success during BOMEX, it is anticipated that this can be achieved in the near future. Refinements to the buoy vehicle, data acquisition systems, turbulence sensor array, and buoy motion sensors are planned with additional bench and field testing in 1970. (auth)

39059 (BNWL-1307(Pt.1), pp 54-9) BACK TRAJECTORIES FROM THE BOMEX ARRAY. Davis, W. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

A series of back trajectories for selected levels was used to find maximum latitude displacement of air parcels sampled over the BOMEX array. The displacement compared with ^{95}Zr measurements over the array indicated high values correlated with displacements from the mid-latitudes of the Northern Hemisphere while low values were correlated with low latitudes or the Southern Hemispheric air. A series of back trajectories from sampling positions around the array indicated in one case the contact of parcels coming from the mid-latitudes with air parcels possibly originating in the Southern Hemisphere. (auth)

39060 (BNWL-1307(Pt.1), pp 60) PRELIMINARY RESULTS FROM RADIONUCLIDE MEASUREMENTS MADE DURING BOMEX. Young, J. A.; Rieck, H. G. Jr.; Robertson, D. E.; Silker, W. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

During the experimental phase of BOMEX, the concentrations of ^{7}Be and several nuclear-weapons-produced radionuclides were measured in air, seawater, and rainwater samples. Although the activities of the radionuclides in the atmosphere rapidly increased above 9.1 km, they remained fairly constant from 0.3 to 9.1 km. Rather large changes in concentration with time and location were observed. Because of its relatively short half-life, ^{7}Be was confined primarily to the top 50 m of the ocean. During the experimental periods, the rate of addition of ^{7}Be to the sea by rainfall was only 10 to 15% of its rate of decay in the sea. (P.C.H.)

39061 (BNWL-1307(Pt.1), pp 62-8) RAFLUX: A NUMERICAL MODEL FOR CALCULATING THE LONG WAVE RADIATIVE TRANSFER IN THE TROPOSPHERE. Scott, B. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

The neglect of radiative cooling in the construction of energy conserving isentropic trajectories can produce serious errors in calculated trajectory end points. A numerical model has therefore been developed to utilize reported pressure, temperature, and moisture profiles for radiative cooling calculations. The theory necessary for the development of the numerical model is briefly discussed, and results of radiation calculations are presented. All calculated radiative flux profiles are in close agreement with those of existing models, thereby suggesting that the assumptions made in the present numerical model are neither too restrictive nor unrealistic. (auth)

39062 (BNWL-1307(Pt.1), pp 70-6) PHORETIC AND BROWNIAN DIFFUSION PROCESSES IN THE BELOW-CLOUD SCAVENGING OF AEROSOL PARTICLES BY RAIN. Slinn, W. G. N.; Hales, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

An analysis was made of the relative importance of thermophoresis, Brownian diffusion, and diffusiophoresis in the below-cloud rain scavenging of aerosol particles. It was found that for particles of radii less than about 0.01 μ, Brownian diffusion is most important. For particles of radii between 0.01 and 1.0 μ, thermophoresis can be dominant. A graph of the resultant washout coefficient is presented, which includes an estimate of the enhancement of the scavenging by thermophoretic effects. (auth)

39063 (BNWL-1307(Pt.1), pp 77-81) FIELD EXPERIMENTS IN PRECIPITATION SCAVENGING. Dana, M. T.; Wolf, M. A.; duPlessis, L. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

Field experiments conducted at Quillayute Air Base on the Olympic Peninsula utilized soluble rhodamine dye particles and sulfur dioxide gas as tracers. Consistency was found in the dye particles though exact deposition velocities could not be assigned. In one experiment, the experimental washout coefficient agreed well with that computed from raindrop size spectra and Mason's collection of efficiencies. Experimental washout coefficients for sulfur dioxide generally fell below theoretical estimates. (auth)

39064 (BNWL-1307(Pt.1), pp 82-6) ROLE OF ANISOTROPIC BROWNIAN DIFFUSION IN THE PRECIPITATION SCAVENGING OF SUBMICRON PARTICLES. Slinn, W. G. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

The concept of anisotropic Brownian diffusion is discussed within the context of precipitation scavenging of submicron particles. The analysis starts from a generalized, convective diffusion equation which contains the influence on the motion of Brownian particles of nonuniformities in the host gas. These effects include tensor diffusivity and "stressphoresis." A boundary layer approximation to the new equation revealed that the corrections to the use of Einstein's diffusion coefficient are insignificant for below-cloud scavenging. Finally, it was indicated that the new effects could be important in flows with large Mach or Knudsen numbers. (auth)

39065 (BNWL-1307(Pt.1), pp 86-91) OLYMPIC PENINSULA RAIN: CHARACTERIZATION OF SIZE AND ELECTRIC CHARGE. Dana, M. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

A number of raindrop charge and size distributions, computed from data collected at a research site on the Olympic Peninsula, have been grouped, and their median values characterized, in terms of rainfall intensity. The median diameter increased at approximately the one-sixth power of rainfall intensity J_0, while the median charges increased at powers of J_0 from one-half to

one. Comparisons of gross size and charge spectra indicated a dependence of the charge upon raindrop area, in agreement with the theoretical proposals of Gunn and Sartor. The rainfall intensity dependency apparently is complicated by a number of meteorological variables. (auth)

39066 (BNWL-1307(Pt.1), pp 92-6) PHORETIC AND BROWNIAN DIFFUSION PROCESSES IN THE IN-CLOUD SCAVENGING OF AEROSOL PARTICLES. Slinn, W. G. N.; Hales, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

An analysis is made of the relative importance of thermophoresis, Brownian diffusion, and diffusiophoresis, for the in-cloud scavenging of aerosol particles, accompanying the condensation and Bergeron–Findeisen process. Under the assumption that all of the latent heat associated with vaporization (condensation) is conducted to (from) the precipitation embryo, it is shown that thermophoresis is of dominant importance for particles of radii between 0.01 to 1.0 μ. The steady-state solution to the appropriate convective-diffusion equation is presented. It is suggested that thermophoresis could be a significant mechanism for the in-cloud contact ice nucleation of water droplets in a subfreezing cloud. (auth)

39067 (BNWL-1307(Pt.1), pp 97-104) A NUMERICAL MODEL TO DESCRIBE OROGRAPHIC PRECIPITATION IN THE PACIFIC NORTHWEST. Scott, B. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

A two-dimensional numerical model is being developed to describe the meteorological events occurring as moisture laden air is orographically lifted over the coastal mountain ranges. The basic equations and limitations of the model are discussed, and some preliminary results from the first test case are presented. (auth)

39068 (BNWL-1307(Pt.1), pp 105-6) COSMOGENIC RADIONUCLIDE TRACERS OF IN-CLOUD SCAVENGING PROCESSES. Perkins, R. W.; Thomas, C. W.; Young, J. A.; Rieck, H. G. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

A sequence for rainwater development is suggested following the observation of three rainstorms in Washington with the cosmogenic tracer technique. The results indicate that light rains have spent a substantially longer period in their development than heavy rains. Rainout coefficients were determined by comparing the radionuclide deposition per unit area at ground level (decay corrected to the time of nucleation) to the radionuclide content per unit area of cloud in an air column of cloud thickness. (P.C.H.)

39069 (BNWL-1307(Pt.1), pp 107-10) INTERPRETATION OF THE IN-CLOUD SCAVENGING OF PARTICULATES. Davis, W. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

Results are presented of a comparison of computed rates of deposition, arrived at by assuming an in-cloud scavenging coefficient, with rates of deposition computed from observations of cosmogenic radionuclides in rainwater. In-cloud scavenging coefficients of 10^{-4} to 10^{-3} sec^{-1} would agree with the deposition rates calculated from observations for ^{24}Na. However, the same coefficients would not predict the rates of deposition calculated from observations of ^{36}Cl. (auth)

39070 (BNWL-1307(Pt.1), pp 111-14) ANISOTROPIC BROWNIAN DIFFUSION IN FREE-MOLECULE COUETTE FLOW. Slinn, W. G. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

Results are given for the theory of Brownian motion of large Knudsen number aerosol particles, hosted by linearized, free-molecule Couette flow. The tensorial diffusion coefficient displays the dependence of diffusion on the viscous stress within the gas. (auth)

39071 (BNWL-1307(Pt.1), pp 115-19) KINETIC THEORY OF DIFFUSELY REFLECTING BROWNIAN PARTICLES. Slinn, W. G. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

An analysis was made of the motion of a spherical Brownian particle whose surface can diffusely reflect the molecules of an equilibrium host gas. The analysis was based on Newton's second law and a limiting form of Markoff's method. It was found, both for specular and diffuse reflections that equipartition of energy is a consequence of the dynamics and randomness of the motion. In addition, it was demonstrated that the diffusion coefficient can depend on the temperature of the particle. The entire analysis was restricted to the case for which the Knudsen number of the particle is large compared to unity. (auth)

39072 (BNWL-1307(Pt.1), pp 122-5) WIND TUNNEL FOR PARTICLE DEPOSITION MEASUREMENTS. Sehmel, G. A.; Schwendiman, L. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

The turbulent deposition of particles was measured for deposition onto 0.7 cm high plastic grass in a 2 ft × 2 ft cross section wind tunnel. Both the particle fluxes and airborne concentration profiles were measured. Deposition velocities are defined to show the mass transfer resistance for the last 1 cm above the grass surface. These dimensionless deposition velocities, K^+, are nearly independent of experimental conditions for the present limited range of experimental conditions. (auth)

39073 (BNWL-1307(Pt.1), pp 126-9) PARTICLE DEPOSITION FROM TURBULENT AIR FLOW. Sehmel, G. A.; Schwendiman, L. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

A theoretical model was developed to describe the turbulent deposition of particles through the boundary layer adjacent to a deposition surface. In this study, the particle eddy diffusivities were back-calculated from the deposition data. From these calculations it was concluded that particle turbulent diffusivities are greater than those for air momentum transfer in turbulent flow. (auth)

39074 (BNWL-1307(Pt.1), pp 132-3) PRERECORDED CLIMATOLOGY OF THE HANFORD REGION. Hinds, W. T.; Thorp, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

Evidence for climatological fluctuations before the start of Weather Bureau cooperative observations in 1913 is being gathered, using growth ring widths of big Sagebrush (Artemisia tridentata). Early indicators seem to be that a dry spell near 1900 ended sooner in the Hanford region than in the Okanogan region, 400 miles north. In the relation of ring width to climate, only 30% of the variance of ring widths is due to winter precipitation. (auth)

39075 (BNWL-1307(Pt.1), pp 133-4) CLIMATE AND PHENOLOGY OF THE ALE RESERVE. Hinds, W. T.; Thorp, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

Results of a phenological survey of more than 100 species are described, including an indication that the persistent mountain-valley inversion over the Columbia Basin may speed phenologic progression at 1000 ft compared to the valley floor (600 ft). (auth)

39076 (BNWL-1307(Pt.1), pp 134-5) FOLIAR INTERCEPTION OF PRECIPITATION IN SAGEBRUSH COMMUNITIES. Hinds, W. T.; Thorp, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

Preliminary results of measurements of precipitation throughfall and nutrient accumulation are presented. Data seem to indicate that potassium is readily available to throughfalling rain, and is probably not due to dissolving minerals in soil particles held on foliage. (auth)

39077 (BNWL-1307(Pt.1), pp 136-8) BIOMETEOROLOGICAL STUDIES OF CONTRASTING SLOPE EXPOSURES. Hinds, W. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 1.

Results of studies in north- and south-facing slopes are described, including phenology (a 30-day lag was noted in the north) and energy fixation (about 8% more energy was fixed per gram biomass on the south-facing slope than on the north, although about 40% more energy was fixed per unit area on the south slope). Average meteorological conditions over the growing seasons were surprisingly similar, but the contrasts at a given moment were notable. (auth)

39078 (NRL-7047) FILTRATION OF PARTICLES OF ATOMIC DIMENSIONS. Saunders, A. W. Jr.; Patterson, R. L. Jr.; Lockhart, L. B. Jr. (Naval Research Lab., Washington, D. C.). 6 Jan 1970. 24p.

Particles of atomic dimensions, as typified by the primary decay products of radon, were readily removed from an air stream by passage through coarse fibrous filters or even through screens, while the radon parent was unaffected. The inverse relationship between the efficiency of removal and the air velocity indicated that diffusion was the mechanism primarily responsible for deposition of these small particles. However, if the particles become attached to aerosols, their collection was governed by aerosol behavior where collection depended both on filter characteristics and air velocity. These particles were readily collected on aerosol particles and provided a radioactive tag by which aerosol or filter behavior may be studied. Such measurements can be extended to size ranges and concentration levels below those convenient for other techniques. (auth)

39079 (PNE-330) BUGGY: SPECIAL CLOUD CONTENT STUDIES. Cohen, Jerry J. (California Univ., Livermore. Lawrence Radiation Lab.). Apr 1970. 20p. Dep. CFSTI.

This report has been issued as UCRL-50825.

Following the detonation of the Project Buggy explosives on March 12, 1968, the variance of radioactivity concentrations within the effluent cloud and the size distribution of radioactive particulates were measured. Parachute samplers were dropped through the cloud, and ground-based sequential samplers and filter packs were stationed along arcs relative to ground zero. The ground-based sequential sampler data indicated that the bulk of the radioactive material was concentrated toward the leading edge of the cloud and it is estimated that about one quarter of the total radioactivity leaving the crater area departed after the initial cloud was formed. (auth)

39080 (PNE-911-F) PROJECT PALANQUIN. ON-SITE RADIOLOGICAL SAFETY REPORT. PLOWSHARE PROGRAM. Mullen, Omer W. (comp.) (Reynolds Electrical and Engineering Co., Inc., Mercury, Nev. Radiological Sciences Dept.). Nov 1965. Contract AT(29-2)-162. 44p. Dep. CFSTI.

The Palanquin Event device was detonated at the Nevada Test Site on April 14, 1965. The test was conducted to explore peaceful uses of nuclear explosions as a part of the Plowshare Program. Remote radiation measurements were taken during and after the event by a telemetry system. Monitors with portable radiation detection instruments surveyed the reentry route into ground zero before other planned entries were made. Continuous surveillance was provided while persons were in radiation areas and appropriate precautions were taken to protect personnel from unnecessary exposure to radiation. Forty-three air sampling trailers were placed at on-site and off-site locations for effluent documentation purposes. The air samples collected were screened and preliminary results, together with the samples, were given to LRL for further analysis. During the period from D Day to D + 12 days, 196 participants were logged through the area control stations. Nine persons received gamma radiation doses greater than the quarterly guide of 3 Rem. These nine personnel received their exposures while working on an event related technical program conducted within the boundaries of the Nevada Test Site. Two of the nine persons received doses in excess of the yearly guide of 5 Rem. The maximum accumulated individual dose was 5.3 Rem. (auth)

39081 WORKS OF THE SOVIET SCIENTISTS IN NUCLEAR METEOROLOGY. Karol, I. L.; Malakhov, S. G.; Makhon'ko, K. P. Iv. Akad. Nauk SSSR, Fiz. Atmos. Okeana; 6: 352-65 (Apr 1970). (In Russian).

A brief survey is given of the most important results obtained in the USSR during the last decade in a field of studying atmospheric natural radioactivity, radioactive aerosol size, and composition as well as regularities of their transport in the atmosphere, self-scavenging of the atmosphere from radioactive contaminants, and use of radioactive nuclides as atmospheric tracers. (auth)

39082 ATMOSPHERIC SCAVENGING OF RADIOISOTOPES. Collection of Papers Delivered at the Conference in Palanga, USSR, 7-9 June 1966. Styro, B. I.; Garbalyauskas, Ch. A.; Luyanas, V. Yu. (eds.). Jerusalem; Israel Program for Scientific Translations Ltd. (1970). 256p. (TT-69-55099; IPST Cat.-5557; CONF-660673). CFSTI.

Translation of Issledovanie Protsessov Samoochishcheniya Atmosfery ot Radioaktivnykh Izotopov by D. Lederman.

Thirty-three papers were presented including general meteorological aspects of atmospheric scavenging of radioactive dust; rate of deposition of radioactive substances from the atmosphere; variation and characterization of radioactive fallout; precipitation washout of radioactive isotopes; radioactivity concentration in surface air during atmospheric scavenging; and washout of isotopes injected into a cloud. (D.H.M.)

39083 EMANATED PRODUCTS AS A PROBE OF ATMOSPHERIC TRANSPORT. Assaf, G. (Weizmann Inst. of Science, Rehovoth, Israel). Tellus; 21: 820-8(1969).

Atmospheric transport of ^{222}Rn, ^{220}Rn and their decay products was analysed in the light of the Richardson diffusion theory, replacing the length scale by a time scale. It was shown that the mean operation involved in the usual procedure of parameterisation of eddy diffusion must be related to the isotopic mean life, and its relation to spectra of atmospheric turbulence. There are cases where the conventional parameterisation of eddy diffusion is inconsistent and contradictory. For example the case of the ^{220}Rn distribution which generally must be treated by Richardson formalism. The conventional methods were shown to be reasonable for interpretation of ^{222}Rn and ^{212}Pb profiles. It was shown that the vertical transport due to the mean wind cannot be neglected. A criterion for estimating the relative importance of advection and eddy diffusion was derived. Application of this criterion established that in the free atmosphere radon transport generally is dominated by advection. This result is demonstrated by semi-uniform numerical model. For a practical application it seemed that the radon could be a promising tool for the study of the large scale (synoptic) vertical wind and of divergent regimes. (auth) (Sweden)

Mineralogy and Exploration

39084 (GJO-933-2) RESEARCH IN URANIUM GEOCHEMISTRY. INVESTIGATIONS OF THE RELATIONSHIP BETWEEN ORGANIC MATTER AND URANIUM DEPOSITS. PART II. EXPERIMENTAL INVESTIGATIONS. Final Report. Schmidt-Collerus, Josef J. (Denver Research Inst., Colo.). Jul 1969. Contract AT(05-1)-933. 192p. (DRI-2513). Dep. CFSTI.

The feasibility of the micropyrolysis-gas chromatography-mass spectrometry (MPGM) method for the characterization of the organic matter associated with uranium in fluviatile ore deposits was investigated. The role of biogenically generated hydrogen sulfide in the reduction and precipitation of uranium in particular in the roll-type deposits was also investigated. It was found that the MPGM method, applied successfully to the characterization ("fingerprinting") of various intractable natural bioliths, can equally well be applied to the characterization of the organic matter in uranium ore deposits and to the study of the nature of this association. The enrichment of uranium in the roll-type deposits appears to be associated principally with the organic matter present and caused by specific ligating moieties in it, the role of hydrogen sulfide is probably of a secondary nature. Nonetheless, if hydrogen sulfide was synergistically involved in the reduction and precipitation of uranium together with the organic matter it is more likely that its origin was mainly biogenic in nature because of the facile availability of organic matter as energy source for the H_2S producing microorganisms. This mechanism for the H_2S production appears also the less complicated one than that assumed for the inorganic mechanisms, involving oxidation of sulfides to sulfites and disproportionation of the latter to form H_2S and sulfates — although the possible simultaneous partial formation by the latter reaction mechanism can not be excluded. (J.R.D.)

39085 DISTRIBUTION OF URANIUM, RARE EARTHS, AND COLOR CENTERS IN A CRYSTAL OF NATURAL ZIRCON. Fielding, P. E. (Univ. of New England, Armidale, Australia). Amer. Mineral.; 55: 428-40(Mar-Apr 1970).

The uranium content and its distribution in a zoned crystal of zircon (hyacinth) was determined by the Lexan print technique. Fluorescence photography and spectroscopy established the distribution of praseodymium. The relationship between these impurities and the color centers responsible for the characteristic red coloration was examined. It is concluded that the centers are Nb^{4+} ions produced by the radiation induced reduction of Nb^{5+} ions which occupy certain Zr^{4+} sites. The presence of a defect, with a characteristic absorption band at 3400 cm^{-1} was required before the reduction could proceed in a natural crystal. (auth)

Oceanography

Refer also to abstracts 39058, 39060, 39145, 39378, 39456, and 39497.

39086 (ORO-3852-3) GEOCHEMICAL BEHAVIOR OF URANIUM AND THORIUM SERIES NUCLIDES. Annual Progress Report. Sackett, William M. (Texas Agricultural and Mechanical

Univ., College Station. Research Foundation). Jun 1970. Contract AT(40-1)-3852. 4p. Dep. CFSTI.

The distribution in the Gulf of Mexico of ^{234}Th generated from ^{238}U in solution in sea water and ^{228}Th generated from ^{228}Ra leached from deep bottom, continental shelf sediments, and introduced in solution via runoff was determined. Phosphate fertilizers were found to greatly increase the amount of uranium in the runoff for the Gulf of Mexico. The amount and isotopic composition of total dissolved inorganic carbon for five stations in the Gulf of Mexico were measured. (G.M.C.)

39087 (PRNC-135, pp 287-94) MATHEMATICAL MODELS USED TO COMPUTE TIME AND SPACE DEPENDENT CONTAMINANT CONCENTRATIONS IN SEAWATER. Gileadi, A. E.; Lowman, F. G. (Puerto Rico Nuclear Center, Mayaguez).

From Radiation and isotope technology in Latin American development.

A simple analytical model is described that uses physical and biological data obtained in field and laboratory investigations, and that will simulate the variation of radioactive contaminant concentrations in water and in plankton due to vertical migration of the plankton and simultaneous metabolic turnover of the contaminant—under a given set of suitable assumptions. Radioactive fallout reaching the surface of the ocean mixes with the seawater—primarily by diffusion and the superimposed action of various currents—and thus presents a potential health hazard to the fish of the sea and subsequently to the human consumers of the potentially contaminated sea food. In an attempt to evaluate the magnitude of this hazard due to radioactive contamination, the time and space dependent concentration of the contaminant in sea water is computed, using a mathematical model which is described. (auth)

39088 (UCSD-34-P-71-10) [STUDY OF THE DISTRIBUTION OF RADIOACTIVITIES IN THE OCEAN]. Annual Progress Report, June 1970. Folsom, T. R. (Scripps Institution of Oceanography, La Jolla, Calif.). Contract AT(04-3)-34. 19p. Dep. CFSTI.

Cs and ^{137}Cs were determined in seawater. The Mt. Soledad Laboratory for the Study of Traces of Radioactivity in the Marine Environment was completed. (M.C.G.)

39089 RADON PROFILES IN THE SEA: A MEASURE OF AIR-SEA EXCHANGE. Schink, David R.; Guinasso, Norman L. Jr.; Charnell, Robert L.; Sigalove, Joel J. (Teledyne Isotopes, (Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 184-93(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A review of factors affecting air-sea gas exchange suggests that the exchange rate may be more dependent upon the rate of sea surface renewal than upon the boundary film thickness. In either case wind velocity dominates the exchange rate. Both the gas exchange rate and the rate of vertical mixing can be evaluated by measurements of the radon profile in the upper 100 m of the water. Radon is extracted from eight depths in the profile using a set of continuous flow extractors which efficiently remove radon and other dissolved gases at flow rates of 1 to 2 l/min. Radon measurements in the Atlantic suggest gas exchange rates corresponding to a transfer velocity of 0.005 to 0.010 cm/sec (film thickness 10 to 20 μ) at wind speeds of 10 to 20 knots. (auth)

Seismology

Refer also to abstracts 39037, 39097, and 39099.

39090 (NVO-1163-205(Vol.3)) EFFECTS OF LOCAL GEOLOGY ON THE AMPLITUDES OF SEISMIC WAVES. VOLUME III. Murphy, J. R.; Weaver, N. L.; Lamers, G. B. (Environmental Research Corp., Alexandria, Va.). Jun 1970. 142p. Dep. CFSTI.

The analyses presented provide additional physical insight into the effects of local geology on the amplitude of seismic motion. The mathematical models available to describe amplification are presented and their limitations indicated. The geology of a number of Nevada Test Site seismic recording stations are described in detail and the quality of the available physical property data assessed. A useable experimental amplification factor is defined in such a way that it is meaningful in terms of the available mathematical models. Experimental amplification factors were obtained for a wide variety of station geologies, ground motion intensities and epicentral distances. The observations are compared with the output of the various analytical models and the validated models subjected to a thorough parameter study. (auth)

39091 (NVO-1163-207) OBSERVED SEISMIC DATA: JORUM EVENT. (Environmental Research Corp., Alexandria, Va.). Apr 1970. Contract AT(29-2)-1163. 90p. Dep. CFSTI.

Results of the processing of the observed ground motions from the Jorum event, a contained underground nuclear device detonated on Pahute Mesa at the Nevada Test Site, are presented. For the purpose of evaluating ground motion prediction procedures used for Jorum, the event yield was assumed to be approximately 1 megaton. Using this assumed event yield, the observed peak resultant vector particle amplitudes as a function of distance are compared with what would be predicted for an event of 1 megaton yield. Similarly, observed 5% pseudo-relative velocity spectra of the horizontal component (radial or transverse) having the peak response are compared with the spectra that would be expected from a 1 megaton event. Data recorded at 41 instrument locations were processed. (auth)

39092 (ORNL-4446, pp 23-5) EARTHQUAKES AND REACTOR SAFETY. Lomenick, T. F.; Wyrick, H. J.; Myers, O. H.; McClain, W. C.; Mott, C. J. (Oak Ridge National Lab., Tenn.).

Laboratory and field tests were made to determine the usefulness of the photoelastic coating technique on representative samples of rock columns for assessing geotectonic activity. Preliminary investigations were made to define the mechanisms causing slope instability in portions of the Atlantic and Gulf coastal plains. A description of the recently activated ORNL seismological station is given, along with a report of significant recordings during the past year. (auth)

39093 (USGS-474-76) SEISMIC REFRACTION SURVEY AT THE UNa SITE, NEVADA TEST SITE, NYE COUNTY, NEVADA. Hazlewood, R. M. (Geological Survey, Denver, Colo.). 1970. 10p. (NTS-226). Dep. CFSTI.

A seismic refraction survey was made by the U. S. Geological Survey at the UNa site, Nevada Test Site. The results of the survey were successful in determining velocities and the depth to bedrock. There is a near-surface velocity of 3,000 feet per second and intermediate velocity of 5,500 feet per second. Bedrock velocity is 11,000 feet per second with depths ranging from 170 to 219 feet. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 38756, 39079, 39080, 39091, 39255, and 39460.

39094 (AD–703320) HIGH-RESOLUTION GAMMA-RAY SPECTROSCOPY STUDY. Quarterly Technical Report. Imhof, W. L. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). 1970. Contract N00014-69-C-0372. 15p. (LMSC–695595). CFSTI.

For nuclear detonations at sufficiently low altitudes the atmosphere will significantly attenuate the emitted gamma rays. For the diagnostic purposes of present concern, it is important to consider whether the atmosphere might introduce additional complications due to Compton scattering which would affect the Compton buildup at lower energies and would contribute to the line broadening. Accordingly, a laboratory study was conducted of the spectral characteristics to be expected from a Ge(Li) detector for those cases with large atmospheric attenuation. The measurements have been oriented primarily toward a study of the effects on the line shapes and on the Compton buildup at the lower energies. (auth) (USGRDR)

39095 (CEA-R–3957(1)) CODE S: CALCULATION OF THE EFFECTS OF CONTROLLED UNDERGROUND EXPLOSIONS. PART I. METHOD OF CALCULATION. Maury, Jacques (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). May 1970. 74p. (In French). Dep. CFSTI (U. S. Sales Only).

A digital Lagrangian code used for solving the equations relating to the mechanics of spherical symmetry continuous media is presented. This code was formulated in order to calculate the effects of nuclear or chemical underground explosions. The propagation of a shock wave front is calculated automatically by the artificial viscosity method due to Von Neumann Richtmyer. The code also makes it possible to deal with the following problems: the flow of a compressible fluid; the vaporization of the surroundings by the shock; the liquefaction of the surroundings by the shock; the crushing and pulverization of the surroundings; the compaction of the surroundings; the opening-up and closing of fractures along one or the other of the two main directions, or along both ones; elastoplastic deformations; elastic deformations; the detonation of a chemical explosive. It is possible to make the plasticity and crushing criteria dependent on the rate of deformation in order to give a best evaluation of the dynamic properties of the firing environment. Various ways of introducing the explosion energy are considered. (auth) (France)

39096 (CGS–746–7) SEISMIC STATION DATA HANDLEY EVENT. (Coast and Geodetic Survey, Las Vegas, Nev. Special Projects Party). 30 Apr 1970. 211p. Dep. CFSTI.

The Special Projects Party of the Coast and Geodetic Survey instrumented Event HANDLEY with 108 seismograph stations located in Nevada, California, Utah, and Arizona. The report presented includes preliminary scaled peak trace surface motions recorded at all sites, the station operation results, and complete descriptions with maps and photographs of all seismograph stations. (D.H.M.)

39097 (JAB–99–63) HARVEY GAP DAM SAFETY STUDY. Seed, H. Bolton; Sherard, James L. (Woodward–Clyde and Associates, Oakland, Calif.). May 1969. 47p. (PNE–R–30). Dep. CFSTI.

For Blume (John A.) and Associates Research Div., San Francisco, Calif.

In preparation for the Rulison explosion, a study was made of the Harvey Gap Dam located approximately 30 km from the proposed explosion. It is an earth dam with a maximum height of about 80 ft. Studies indicated that the water level in the reservoir should be lowered to at least 10 ft below the crest of the dam before the explosion and that provisions should be made for rapid sealing of any cracks that might develop. Careful observations of the displacements of the crest of the dam should be made both during and following the explosion. The dynamic response of the dam to ground motions, a stability analysis of the dam, and an evaluation of the possible extent of damage to the embankment are discussed. (M.C.G.)

39098 (NVO–1163–210) OBSERVED SEISMIC DATA, PIPKIN EVENT. (Environmental Research Corp., Alexandria, Va.). May 1970. Contract AT(29-2)-1163. 70p. Dep. CFSTI.

The results of the processing of the observed ground motions for the Pipkin Event, an underground nuclear detonation on Pahute Mesa at the Nevada Test Site are presented. Ground motion data recorded at 36 instrument stations deployed by the United States Coast & Geodetic Survey were processed by Environmental Research Corporation Data Processing Laboratory. The peak resultant vector amplitudes were calculated and plotted as a function of distance and regression equations were derived. Pseudo-Relative Velocity Spectra at 5% damping were derived from the velocity seismograms. (auth)

39099 (NVO–1163–TM–20) ANALYSIS OF SELECTED EFFECTS ON PEAK GROUND MOTIONS GENERATED BY UNDERGROUND NUCLEAR DETONATIONS. Whipple, A. P.; O'Brien, L. J. (Environmental Research Corp., Alexandria, Va.). Jun 1970. Contract AT(29-2)-1163. 83p. Dep. CFSTI.

Ground motion peak amplitude data recorded from 109 underground nuclear events varying in yield from about 1 kt to over one megaton are analyzed. The total ground motion measurements, recorded at approximately 600 different recording sites, include 1,344 acceleration, 910 velocity, and 1,342 displacement values of the peak resultant vector. The study of this large, diversified data sample resulted in a set of peak ground motion prediction equations for hard rock and alluvium recording site media. Several relatively homogeneous subgroupings are considered to establish the relationship among several independent variables. The variables examined are: the lithology at the recording site and at the detonation source; the source medium water saturation; the source location; and the peak amplitude of the individual components of ground motion. Each of these variables is examined with respect to the yield of the detonation, and the distance to the recording site. It was concluded that the recording site medium and the detonation site medium significantly affect the ground motions recorded at a particular site. The source location, per se, is probably not an important parameter, except for its contribution to transmission path differences. Regression equations expressing peak vector amplitude as a power law function of yield and range were derived in order to predict the peak resultant vector ground motion at hard rock and alluvium sites. These equations are quite similar to those given by Murphy and Lahoud (1969). Regression equations were also derived to establish relationships among some of the most common source media (tuff, alluvium, and rhyolite; wet and dry), and between the Yucca Flat and Pahute Mesa source locations. Other regression equations were also derived for the prediction of ground motions corresponding to each of the three mutually orthogonal instrument orientations, subdivided according to hard rock and alluvium recording sites. (auth)

39100 (PNE–R–29) RULISON COURT DECISION CONCERNED WITH POSTSHOT FLARING PROGRAM. (District Court (U. S.), Denver, Colo.) 19 Mar 1970. 73p. Dep. CFSTI.

An opinion and order memorandum is presented. The issues of law and issues of fact are discussed and the decision of the court in favor of the defendants, Dr. Glenn Seaborg, Austral Oil Company, and CER Geonuclear Corporation, given. (M.C.G.)

39101 (UCRL–12065(Pt.3)) LABORATORY VERIFICATION OF EXPLOSION CALCULATIONS. PART III. GROUT, A ROCK-LIKE LOCKING SOLID. Hearst, Joseph R.; Cherry, J. Theodore; Brown, Stephen R. (California Univ., Livermore. Lawrence Radiation Lab.). 14 Apr 1970. 19p. Dep. CFSTI.

Data on spherical explosions in grout, a locking solid with properties similar to those of rock, have been compared with computer calculation results. It was necessary to introduce a strain-rate-dependent term in the calculation of deviatoric stress to obtain agreement between calculation and experiment. Measurements of radius of multiple cracking and of free surface velocity agreed well. Measurements of stress, whose validity is not certain, agreed fairly well at stress levels between 0.4 kb and about 10 kb. Below 0.4 kb agreement was less good. (auth)

39102 LA NON-PROLIFERATION DES ARMES NUCLEAIRES. (Non-Proliferation of Nuclear Arms). Fischer, Georges. Bibliotheque de Droit International, Tome L. Paris; Librairie Generale de Droit et de Jurisprudence (1969). 248p. 36,30 F.

A rapid review is given of the origin, elaboration, and dispositions of the new treaty on non-proliferation of nuclear arms. The antecedents, the problem of non-proliferation, the elaboration of the treaty, the interdiction against the transfer, receipt, and fabrication of nuclear arms, the international collaboration in the area of pacific utilization, the final clauses of the treaty, the safety of the non-nuclear nations, and the collateral measures are studied and considered in succession. (J.S.R.)

Facilities and Equipment

Refer also to abstracts 39629, 39700, 39716, 39987, and 39995.

39103 (DP-Report-62) SKINNER VALVE LEAK TESTS. Project DRAGON. Kay, J. M. E. (Atomic Energy Establishment, Winfrith (England)). Oct 1961. 8p. Dep. CFSTI.

The results of tests on a batch of identical standard Skinner Electric Valves are presented. The test conditions for the helium leak rate investigation are given. (auth)

39104 (DP-Report-106) SKINNER VALVE LEAK TESTS. Project DRAGON. Kay, J. M. E.; Hollick, R. C. (Atomic Energy Establishment, Winfrith (England)). Aug 1962. 17p. Dep. CFSTI.

Tests were carried out with the plunger spring removed. The normally mounted valve withstood a pressure of 315 psi abs with comparatively small leakage across the plunger seat. With the reverse mounted valve leakage occurred across the plunger seat for any gas pressure difference across the valve. (auth)

39105 (DP-Report-119) AN APPARATUS FOR MEASURING THE YOUNG'S MODULUS OF FULL SIZE DRAGON GRAPHITE FUEL TUBES USING A NON-DESTRUCTIVE METHOD. Project DRAGON. Thomsen, T. B. (Atomic Energy Establishment, Winfrith (England)). Nov 1962. 16p. Dep. CFSTI.

Using the relationship between Young's modulus, density, and the velocity of sound in a medium it is possible to calculate Young's modulus for the fuel tube from a knowledge of its fundamental frequency. The apparatus was designed specifically to allow its use in a high activity handling cell. (auth)

39106 (DP-Report-125) A POWER CONNECTOR FOR THE GRAPHITE HEATERS IN THE SEVEN ELEMENT EXPERIMENT. Project DRAGON. Kingdon, J. (Atomic Energy Establishment, Winfrith (England)). Nov 1962. 10p. Dep. CFSTI.

A power connector for the heating elements in the Seven Element Rig was designed and tested to pass four hundred amperes, while running at a temperature of 350°C in an argon atmosphere. (auth)

39107 (DP-Report-160) TESTS ON TEDDINGTON VALVES. Project DRAGON. Woodley, H. J. (Atomic Energy Establishment, Winfrith (England)). Feb 1963. 22p. Dep. CFSTI.

Operational tests were carried out on a batch of four Teddington valves. Three were manufactured in accordance with Dragon Design Office instructions based upon the results of previous successful test experience. These three valves utilized right angled plugs working in conjunction with sharp edged seats. The seats were all manufactured from EN 58B Austenitic Stainless Steel and were used with plugs of Nitrided EN 41A, Stellite and EN 57 Martensitic Stainless Steel. Good results were obtained using nitrided and stellite plugs but the EN 57 material proved to be too soft. The fourth valve was taken from a standard production batch and was proved to be unsatisfactory in its present form. (auth)

39108 (DP-Report-169) AN APPARATUS TO MEASURE THE EFFECTS OF IRRADIATION ON THE THERMAL CONDUCTIVITY OF DRAGON TYPE FUEL TUBES. Project DRAGON. Pass, H. (Atomic Energy Establishment, Winfrith (England)). Mar 1963. 16p. Dep. CFSTI.

This is an apparatus designed specifically to measure the thermal conductivity of fuel tubes under remote handling conditions. It utilizes molten tin as the heat transfer fluid in a radial heat flow device. Results of conductivity measurements on an irradiated fuel tube are presented. (auth)

39109 (DP-Report-201) HELIUM LEAK TESTING TECHNIQUES: CONTAINMENT OF HELIUM ESCAPING FROM LEAKS BY POLYTHENE SHEETS. Project DRAGON. Milne, J.; Hammond, A. D. (Atomic Energy Establishment, Winfrith (England)). Jul 1963. 26p. Dep. CFSTI.

The basic principles of mass spectrometer helium leak testing of large pressure vessels using polythene sheet as a secondary containment have been investigated and experimental results obtained. Techniques of calibrating helium leaks, measuring the helium diffusion rates through pinholes and measuring permeabilities to helium of polythene are described. (auth)

39110 (DP-Report-299) CONTROL SCHEME FOR RATEAU BLOWERS. Project DRAGON. (Aish and Co., Ltd., Poole (England). Nov 1964. 16p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, England.

Modifications necessary to the existing electrical and control system in order to operate Rateau blowers with pad type bearings in the primary circuit of the Dragon reactor using Brown-Boveri variable frequency generating sets are described. (auth)

39111 (HUX-3807-3) FLOATING ROOF CONTAINMENT VESSEL. Semiannual Progress Report, September 1, 1969-February 28, 1970. First, Melvin W. (Harvard School of Public Health, Boston, Mass.). Contract AT(30-1)-3807. 6p. Dep. CFSTI.

Results of tests are reported on a floating roof reactor containment vessel to estimate leakage during loss of coolant accidents and during holding periods when the roof settles to its normal position. No gas escape was noted during static or dynamic smoke tests. Test data for the experiments are included. (J.R.D.)

39112 (NP-10266) THE SINGLE CHANNEL LOW TEMPERATURE HEAT TRANSFER RIG DESIGN, CONSTRUCTION, AND COMMISSIONING. Project DRAGON. Robinson, C. H.; Hansen, K. (Atomic Energy Establishment, Winfrith (England)). Apr 1961. 43p. (DP-Report-21). Dep. CFSTI.

The design of an apparatus to measure the heat transfer and fluid flow characteristics of a channel simulating the Dragon reactor coolant channel, and also capable of evaluating the effects of simple modifications to the heat transfer surfaces is described. The experimental and analytical techniques used with this apparatus are detailed. Their validity is assessed by comparing results obtained with a smooth cylindrical channel with previously published work. (auth)

39113 (NP-18292) DESIGN OF A REPAIR DEVICE FOR A SODIUM-SODIUM HEAT EXCHANGER. Cramer, M.; Hitzschke, U.; Schultheiss, G. F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Oct 1969. 35p. (In German). Dep. CFSTI (U. S. Sales Only).

The preliminary repair steps of a Na/Na-heat exchanger are briefly described. Some possibilities of blockage of destroyed tubes are discussed. For final design a manipulator and the explosive welding of the tube-plugs were chosen. This method was independent of the heat exchanger tube design and needed no difficult cleaning processes. A description of the design and the handling is added. (auth)

39114 (ORNL-TM-2909) STEAM TURBINE-GENERATOR CYCLE EFFICIENCY FOR DESALTING APPLICATIONS. Fuller, L. C. (Oak Ridge National Lab., Tenn.). Jul 1970. Contract W-7405-eng-26. 59p. Dep. CFSTI.

Tables and graphs were prepared for rapid estimation of turbine cycle efficiency and heat rate, feedwater pumping power, throttle steam flow, exhaust steam flow, and exhaust enthalpy for steam turbine-generator cycles. In place of the usual detailed turbine cycle heat-balance calculations, the tables and graphs can be used to make rapid determinations of performance data for steam turbines in power-only applications or in dual-purpose plants for desalting and power generation. The tables and charts cover throttle steam conditions from saturation to 300°F of superheat and from 400- to 2400-psia pressure, with exhaust at 1.5 in. Hg abs, 15 psia, and 35 psia. Cycle descriptions, flow diagrams, and a sample problem are presented. Calculations were performed by using the ORCENT computer code for steam turbine cycle analysis. (auth)

39115 (PRNC-135, pp 87-92) INSTALLATION AND CALIBRATION OF A RADIATION UNIT. Solanas, Joaquin; Trujillo, Ivan (Instituto Venezolano de Investigaciones Cientificas, Caracas). (In Spanish).

From Radiation and isotope technology in Latin American development.

The experience obtained in the installation of the radiation unit with two cobalt-60 sources of 500 and 10,000 curies is described. Topics discussed include: description of original installation and its transformation into an irradiation unit; assembly and installation of two sources in the same unit; radiological safety in the installation; calibration methods used; and research programs carried out with this unit. (auth)

39116 (PRNC-135, pp 507-14) SOURCE UNIFORMITY AND TRANSIT DOSE IN A $^{90}Sr-^{90}Y$ BLOOD IRRADIATOR. Rothbart, M. A.; Davis, C. R.; Muller, A. C.; Hill, F. B. (Brookhaven National Lab., Upton, N. Y.).

From Radiation and isotope technology in Latin American development.

Irradiators having $^{90}Sr-^{90}Y$ beta particle sources can be designed to produce adequately high dose rates while at the same time remaining compact and portable. These characteristics are all desirable in irradiators for the extracorporeal treatment of body fluids. The characteristics of a small scale prototype blood irradiator with a $^{90}Sr-^{90}Y$ source were determined. The irradiator was designed and built by the Atlantic Research Corporation.

Source uniformity and transit dose were evaluated experimentally. Uniformity of treatment and potential for scale-up are discussed. (auth)

39117 (RD/B/M-1366) APPARATUS DESIGNED TO STUDY THERMAL AND MECHANICAL FATIGUE IN METALS. Marrow, A. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jun 1969. 13p. Dep. CFSTI (U. S. Sales Only).

Numerous power plant component failures are attributable to a combination of cyclic, thermal, and mechanical stresses. An apparatus was designed and developed to investigate materials deformation and failure criteria, which predominate at the high strain region of 10^3 to 10^4 cycles to failure. (auth)

39118 (RD/B/N-1600) A RADIONUCLIDE IDENTIFICATION FACILITY AT BERKELEY NUCLEAR LABORATORIES. Christie, H. M. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Apr 1970. 41p. Dep. CFSTI (U. S. Sales Only).

The equipment and techniques available for the measurement and identification of alpha, beta, x- and gamma-emitting radionuclides are described. (auth) (UK)

39119 (RD/B/N-1624) A NEW REMOTE POSITIONING FACILITY FOR THE CALIBRATION OF GAMMA RADIATION INSTRUMENTS AT HIGH EXPOSURE RATES. Lavender, A. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Mar 1970. 13p. Dep. CFSTI (U. S. Sales Only).

A facility was constructed for the remote selection of either a 3.5 Ci or a 21 Ci ^{60}Co source and its safe transfer to calibration jigs in a well-shielded cell. Exposure levels from a few $R.h^{-1}$ to thousands of $R.h^{-1}$ are obtained by remote positioning of the instrument calibration stand relative to the selected source. When handling such large sources, safety of operating personnel is of prime importance and hence the facility was designed so that all operations are controlled from outside the shielded exposure room. (auth) (UK)

39120 CURIETRON, A NEW TOOL FOR PLESIORADIOTHERAPY. Loverado, Andre (Appareils Gamma Star (AGS), Levallois-Perret, France). Ind. At.; 14: 41-5(1970). (In French).

The technical characteristics and main advantages of a new projector of radioactive sources associated with miniaturized sealed sources of cesium-137 are described. This apparatus, developed in France by the CEA and the A.G.S. Company for gynecological plesioradiotherapy, is quite safe for the hospital staff, is very effectively handled and has a superior adaptation to treatments. Further developments towards reducing the treatment time are outlined. (auth) (France)

39121 NEW GAMMA-IRRADIATION FACILITY. Furuta, Junichiro; Hiraoka, Eiichi; Okamoto, Shinichi; Fujishiro, Masatoshi; Kanazawa, Tamotsu; Ohnishi, Tokuhiro; Tsujii, Yukio; Azuma, Toshio. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 65-70 (1969).

A new gamma-irradiation facility has been completed in 1969. The facility is composed of a irradiation pool and a hot cave for 100 kCi of ^{60}Co. The inner surface of pool (3 m × 5 m in area, 5 m in depth) is lined with stainless steel plates of 3.2 mm in thickness, and the pool water is always circulated through a filter and a purifier. In this pool, a newly designed conveyer is installed by which a large amount of samples can be irradiated continuously. The details of facility and the gamma-flux distributions around the sources are described. (auth)

39122 EFFICIENCY OF USING A STEAM GENERATOR AT AN ATOMIC ENERGY PLANT. Dvornikov, A. F. At. Energ. (USSR); 28: 239-40(Mar 1970). (In Russian).

The efficiency of steam generators can be improved by the use of a low-pressure turbine after the high-pressure turbine. The second turbine is fed by secondary vapor generated by exhaust steam from the high-pressure turbine. The main advantages of this arrangement are that the condenser for the low-pressure turbine supplies feedwater to the high-pressure vapor generator, and this system can cover peak loads by supplying steam directly to the low-pressure turbine. Seawater can be used for the cooling condensers. The economic costs for this arrangement are compared with the conventional arrangement for a dual-purpose atomic energy plant producing electrical energy and distilled water. These figures show that the more uneven is the electrical load, the greater are the savings with the use of the second low-pressure turbine. (TTT).

39123 AXIAL-MECHANISM CONTROL-ROD ACTUATOR. Pflugrad, Kurt (to Commissariat a l'Energie Atomique). U. S. Patent 3,515,639. 2 Jun 1970. Filed 16 Nov 1967.

A control rod actuator is described for a nuclear reactor comprising a leak-tight containment vessel and closed by a top seal plug. The actuator comprises a vertical translation mechanism which traverses the seal plug and is coupled at its upper end to a drive unit and at its lower end to said control rod by means of a releasable system. The vertical translation mechanism has two sections which can be engaged in end-to-end relation by coupling means. The upper section is adapted to slide within a guide tube carried by an arm which is rotatable about a vertical axis and fitted with a releasable bolt for retaining the lower section in the bottom position. (auth)

39124 ALLOYS CONTAINING BORON. Remenyi, Joseph (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,199,030. 15 Jul 1970. Priority date 23 Dec 1966, Germany.

A process for production of Cr-Ni control element steels is described in which Cr is ~30% by wt and ^{10}B is incorporated at least 2% by wt for use as neutron absorber in reactors. The ^{10}B is added as ferroboron. (J.R.D.)

39125 FIELD ION MICROSCOPY. PRINCIPLES AND APPLICATIONS. Mueller, Erwin W.; Tsong, Tien Tzou. New York; American Elsevier Publishing Company, Inc. (1969). 320p. $19.00.

A review of theory, experimental findings, and methods for field ion microscopy is presented. Information is included on fundamentals, field ionization, field evaporation, design and operation, techniques, interpretation, and uses. (J.R.D.)

39126 ELECTRIC CURRENT GENERATING CELL INCLUDING RADIOACTIVE MATERIAL. Walker, John B. U. S. Patent 3,497,392. 24 Feb 1970. Filed 27 Sep 1965.

A porous core in a case is sensitive to ultraviolet radiations produced by a fluid that surrounds the core and fills its pores and that is ionized by radioactive material surrounded by the core. The radiations activate the core to produce electric current that is conducted away from the core by means electrically connected with it and extending out of the case. (auth)

39127 IMPROVEMENTS IN AND RELATING TO HANDLING EQUIPMENT FOR FUEL ELEMENTS IN A NUCLEAR REACTOR. Cavy, Claude; Tissot, Roland (to Commissariat a l'Energie Atomique). British Patent 1,194,937. 17 Jun 1970. Priority date 25 Apr 1967, France.

Design of safe handling equipment for fuel elements is described which comprises a handling grab movable in axial translation along a guide tube, means for vertically aligning the guide tube with individual fuel elements, and control elements for grab fingers and handling grab assembly. (J.R.D.)

39128 OPTIMUM ONE-DIMENSIONAL MAGNETOHYDRODYNAMIC SLIDER BEARING. Shukla, J. B. (Marshall Space Flight Center, Huntsville, Ala.). J. Lubric. Technol.; 92: 530-4(Jul 1970).

The techniques of the calculus of variations are used to study the general problems in magnetohydrodynamic lubrication when two or more control variables are bounded. The load integral, in the case of a magnetohydrodynamic slider bearing, is maximized with film thickness and conductivity functions as bounded control variables. It is shown that if the conductivity of a bearing surface is of step-type function then uniformly applied magnetic fields are more advantageous. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 39042, 39112, 39113, 39599, 39603, 39732, 39736, 40948, and 40951–40953.

39129 (CONF-690614-(Summ.)) THE CHAIRMEN'S SUMMARIES OF THE PAPERS PRESENTED AT THE EUROPEAN TWO-PHASE FLOW MEETING, JUNE 1969, KARLSRUHE. ([Allgemeine Elektricitaets-Gesellschaft, AEG-Telefunken, Frankfurt am Main (West Germany)]). 63p.

A summary is presented of the 47 papers presented at the conference on thermodynamic aspects of two-phase flow. (J.R.D.)

39130 (DP-Report-113) ESTIMATE OF FILM BOILING SAFETY MARGIN IN DRAGON PRIMARY HEAT EXCHANGER. Project DRAGON. Husain, L. A. (Atomic Energy Establishment, Winfrith (England)). Oct 1962. 26p. Dep. CFSTI.

Experimental results show that the gas-side heat transfer and friction characteristics agree with predictions from published data. A brief survey of burnout for tubes indicates that no directly applicable data exist for the Dragon heat exchanger. An empirical correlation is therefore devised and used to estimate the order of the safety margin which is found to be between 2 and 5. (auth)

39131 (DP-Report-126(Pt.I)) THE DRAGON FREEZER. PART I. A THEORETICAL INVESTIGATION OF THE HEAT TRANSFER PERFORMANCE. Project DRAGON. Husain, L. A. (Atomic Energy Establishment, Winfrith (England)). Jan 1963. 26p. Dep. CFSTI.

Simple performance and fault condition relations are presented from which it is deduced that the apparently poor heat transfer performance of the prototype is due to physical blockage of one or more parallel channels in both stages, aggravated by adverse natural convection effects in Stage 2. (auth)

39132 (DP-Report-126(Pt.II)) THE DRAGON FREEZER. PART II. EXPERIMENTAL HEAT TRANSFER AND FRICTION RESULTS FOR SINGLE ELEMENTS. Project DRAGON. Husain, L. A.; Robinson, C. H. (Atomic Energy Establishment, Winfrith (England)). Feb 1963. 27p. Dep. CFSTI.

Experimental results on single heat transfer elements from both Freezer stages indicated overall heat transfer coefficients only some 30 to 40% of those predicted. Subsidiary experiments suggested that the design correlation was adequate and that the poor performance was due to a manufacturing fault. Isothermal friction results are also presented. (auth)

39133 (RD/B/N-1630) RADIAL DISTRIBUTION OF BUBBLES IN SODIUM FLOWING THROUGH HEATED CHANNELS. Holland, P. K. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Mar 1970. 11p. Dep. CFSTI (U. S. Sales Only).

Expressions are obtained for the forces on small bubbles in heated turbulent flows. These expressions show that argon bubbles in the sodium coolant flowing through a fast reactor core will be concentrated near the fuel pins. (auth) (UK)

39134 IETI-3: AN OUT-OF-PILE FACILITY FOR HEAT TRANSFER TESTS OF FULL SCALE REACTOR POWER CHANNELS COOLED WITH EVAPORATING WATER. Hassid, A.; Ravetta, R.; Rubiera, L. (CISE, Milan). Energ. Nucl. (Milan); 17: 347-58(Jun 1970).

The main characteristics of IETI-3 (Impianto per Esperienze Termoidrauliche N. 3, i.e., Facility for Thermohydraulic Tests N. 3) are described. This facility was designed and built by CISE at the ENEL Emilia Power Station in Piacenza, for thermal and hydraulic experiments on test sections reproducing nuclear reactor power channels at full scale. The facility has been operating at full power since 1967 and is essentially used in the CIRENE reactor research and development program. The plant's main improvements made after IETI-3 commissioning are also described. (auth)

39135 BASIC RELATIONSHIPS OF TURBULENT FLOW NEAR THE WALL LAYER. Millionshchikov, M. D. At. Energ. (USSR); 28: 317-20(Apr 1970). (In Russian).

With the development of turbulence in the main stream, it is assumed that laminar flow always exists at the wall at a distance depending on the critical Reynolds number. The laminar flow loses its stability at large values of the Reynolds number. Vortices occur, at first at a low Reynolds number. These vortices create a flow with a more or less regularly alternating pulsation in velocity which also loses its stability with increasing Reynolds number. Finally a statistically ordered mode of flow is established, and this flow is called turbulent flow. Equations are presented to describe this model of turbulent flow. It is found that the velocity distribution is logarithmic for the region of developing turbulence. The vortices oscillate with a velocity determined by the extremum of a functional which is related to the specific resistance and kinetic energy of the flow stream. These theoretical relations give velocity distributions over the entire range from laminar flow to fully developed turbulence. (TTT)

39136 CALCULATION OF A HEAT-EXCHANGE CRISIS UNDER DISPERSIVE-ANNULAR CONDITIONS OF FLOW OF A TWO-PHASE MIXTURE AT LOW PRESSURES. Davydova, M. V.; Zelenskii, V. N.; Kirillov, P. L. This paper was summarized in At. Energ. (USSR); 26: 57-8(Jan 1969) as paper No. 257. (In Russian).

A model of heat exchange crisis under dispersive-annular conditions of flow is described in which the crisis is attributed to the disappearance of a liquid film next to the wall corresponding to a transition from dispersive-annular to purely dispersive conditions. An expression of critical heat flow is derived by integrating the mass balance equations in the film from the lower limit of the dispersive-annular region to its upper limit where the film next to the wall disappears. The vapor content at low pressures is calculated by Wallis's formula for the minimum velocity of a gas at which the wall film is retained in vertical once-through flow. (J.R.D.)

39137 TRANSPORT PHENOMENA IN FLUIDS. Hanley, Howard J. M. (ed.). New York; Marcel Dekker, Inc. (1969). 518p. $17.50.

The following chapters are included: (1) hydrodynamics, (2) nonequilibrium thermodynamics, (3) discontinuous systems, (4) statistical theory of irreversible processes, (5) kinetic theory of dilute gases, (6) kinetic theory of moderately dense gases, (7) time-correlation functions, (8) experimental comments on dilute gas transport expressions, (9) thermal diffusion, (10) experimental verification of the Onsager reciprocal relations, and (11) biological aspects of transport. (M.O.W.)

Isotope Technology

Refer also to abstracts 39035, 39040, 39043, 39115, 39116, 39119–39121, 39168, 39321, 39387, and 39709.

39138 (AI-AEC-12968) LARGE RADIOISOTOPE HEAT SOURCE CAPSULE (LRHSC). Twelfth Quarterly Progress Report, April–June 1970. (Atomics International, Canoga Park, Calif.). 3 Jul 1970. Contract AT(29-2)-2338. 77p. Dep. CFSTI.

Efforts devoted to hardware design and fabrication for other tasks are summarized. Progress on creep testing is reported along with capsule materials compatibility testing and transit capsule support research. Results of transit heat source verification tests are reported and a tabulation of transit capsule piece-parts is included. (J.R.D.)

39139 (BNWL-1308-2) DIVISION OF ISOTOPE DEVELOPMENT PROGRAMS QUARTERLY REPORT: FEBRUARY–APRIL 1970. Hansen, J. E. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1970. Contract AT(45-1)-1830. 66p. Dep. CFSTI.

Results of investigations of isotopic fuels are presented. Data and information are included on laser uses, Pm compatibility, waste Cs as radiation source, characteristics of fission product Rh and Pd, uses of fission product Xe, radiography using ^{252}Cf, source development, power reactor isotope production, isotopic heat sources for circulatory assist devices, and nuclear methods for seabed prospecting. (J.R.D.)

39140 (ORNL-IIC-24(Rev.1)) ISOTOPES INFORMATION CENTER KEYWORD THESAURUS. Lafferty, Robert H. Jr. (ed.) (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 115p. Dep. CFSTI.

39141 (PRNC-135) RADIATION AND ISOTOPE TECHNOLOGY IN LATIN AMERICAN DEVELOPMENT. Proceedings of the American Nuclear Society Topical Meeting, San Juan, Puerto Rico, May 4–6, 1969. (Puerto Rico Nuclear Center, San Juan). Contract AT(40-1)-1833. 519p. (CONF-690508). Dep. CFSTI.

Sixty-seven articles are included; separate abstracts were prepared for 46. Of the remaining 21 articles, one was previously included in NSA as 24: 19027. Abstracts only are included for 13 papers. These contain information on Brookhaven chemonuclear in-pile research loop; preparation of ^{131}-I-labeled allyl-inulin with high radiochemical yield; progress on polymer-containing fibrous materials around the world; U trace analysis by pulsed reactor irradiation; association of methods of activation analysis and isotopic dilution for determination of Cu in high purity Ag; industrial applications of radioisotopes; remote portable nuclear instrumental methods for elemental analysis; experimental test of mathematical model predicting T movement through a tropical rain forest; measurements of H_2O behavior in tropical trees using tritiated water; application of radioisotopic tracers in problems of secondary oil recovery; and a high resolution $4\pi\ \alpha$ spectrometer and its use in geology. The remaining 7 papers contain information on: known resources and levels of development in Latin America; radioisotope and radiation applications in the U. S.; radiation processing in industry; copolymerization of butyl acrylate, methyl methacrylate, and styrene initiated by free radicals using ^{14}C-labeled monomers; and movement of phosphamidon-^{32}P from the oropharyngeal cavity to the brain. (P.C.H.)

For abstracts of individual papers see: 38713, 38770–38778, 38899, 38995, 38996, 39039–39043, 39087, 39115, 39116, 39142–39152, 39168, 39223, 39376–39378, 39415, 39527, 39528, 39583, 39589, 39591, 39597, 39733, and 39734.

39142 (PRNC-135, pp 65-72) PANORAMA OF RADIOISOTOPE APPLICATIONS IN LATIN AMERICA. Baro, G. B.;F Flegenheimer, J. G. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). (In Spanish).

From Radiation and isotope technology in Latin American development.

A summary is presented of the growth and diversity of radioisotope uses in Latin America, particularly in Argentina and Brazil. (L.C.L.)

39143 (PRNC-135, pp 73-6) AVAILABILITY OF ISOTOPE SUPPLY AS SEEN FROM LATIN AMERICA. Facetti M., Juan F. (Asuncion Univ. (Paraguay). Instituto de Ciencias). (In Spanish).

From Radiation and isotope technology in Latin American development.

The availability of radioisotopes in Latin America from domestic production facilities and by importation is reviewed. (L.C.L.)

39144 (PRNC-135, pp 100-5) ACTIVITIES OF THE ARGENTINE ATOMIC ENERGY COMMISSION IN RADIOISOTOPE APPLICATIONS IN BIOLOGY AND INDUSTRY. Gonzales, R. O.; Mariano, E. E.; Mugliaroli, H. A.; Phissa Campa, J.; Papadopulos, C. C. (Puerto Rico Nuclear Center, Mayaguez). (In Spanish).

From Radiation and isotope technology in Latin American development.

Research related to radioisotope applications in chemical or biological systems, as well as with farm or industrial products, is done by the National Atomic Energy Commission, through its Division of Intensive Radiation Sources. The Division receives occasional collaboration from other official or private organizations who are either interested or specialized in the problem. Some of the main activities either accomplished or in progress are described and include: design and production of a semi-industrial radiation plant; analysis of irradiated wheat; inhibition of sprouting of tubers; economic study of radiation conservation of potatoes; irradiation of bovine blood albumin; polymerization of plastics grafted in woods; radiation preservation of fresh fish; industrial gamma radiation; supporting research; professional training; and regional reference center for secondary dosimetry patterns. (auth)

39145 (PRNC-135, pp 263) A UNIQUE UNDERWATER SURVEY SYSTEM FOR OBTAINING DATA CONCERNING SAND TRANSPORT IN THE LITTORAL ZONE OF THE OCEAN. Case, F. N.; Acree, E. H.; Brashear, H. R. (Oak Ridge National Lab., Tenn.).

From Radiation and isotope technology in Latin American development.

A broad study was started at Oak Ridge National Laboratory in 1966 as a cooperative effort with other federal agencies to develop technology and survey equipment to obtain data from a dynamic system that could be treated to yield a reasonably accurate description of sediment transport systems involving waterways and inland lakes. The study was divided into six major related efforts: development of a survey system that could be reliably operated in the field and have a high degree of versatility relative to environmental variables and choice of radionuclide for tagging sediment; evaluation of various radionuclides to determine those useful in sediment transport experiments (cost, physical properties, availability, and hazard); development of techniques for in situ determination of sand burial; development of suitable tagging procedures; demonstration of the utility of the system under field conditions; and correlation of sand transport with wave and current variables and development of computer programs for processing the data into useful profiles of sediment transport. (auth)

39146 (PRNC-135, pp 360-74) PRESENT AND FUTURE PROSPECTS OF RADIOISOTOPE APPLICATIONS IN ARGENTINE INDUSTRY. Baro, Gregorio B.; Castagnet, Antonio C. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). (In Spanish).

From Radiation and isotope technology in Latin American development.

The present status and prospects for radioisotopes in Argentina's industry are described, with some statistical, technical, and economic references to the most important applications, pointing out in particular those developed in the CNEA. A wide variety of techniques and equipment which use radioisotopes, either as tracers or as sealed radiation sources are being utilized in Argentina. Tracers are being used in engineering processes to determine stable stages, volume of materials in evolution, location of losses and obstructions in pipes, contamination studies, waste and corrosion, lubrication efficiency, etc. and in hydraulic engineering to measure flow and to study the movement of sediments in coastal and fluvial areas. Some of these applications also include neutron activation analysis. Sealed sources are used to control processes and quality of manufactured products, for oil well cross section studies, and to measure soil compactness and humidity for road building. The National Atomic Energy Commission created and stimulated the development and application of radioisotopes in Argentine industry. Today private companies produce and use nuclear techniques and equipment. Tangible benefits in cost and quality are obtained by their use. (auth)

39147 (PRNC-135, pp 375-82) MERCURY BALANCE IN ELECTROLYTIC CELLS WITH RADIOACTIVE TRACERS. Gomez Ruiz, Hector; Rocca, Hector C.; Garcia Agudo, Edmundo (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). (In Spanish).

From Radiation and isotope technology in Latin American development.

The method and results obtained using a radioactive tracer to measure the mercury balance in forty electrolytic cells are described. The cells are used to produce sodium hydroxide and chlorine; the metallic mercury is the mobile cathode of the cells. The tracer used was ^{197}Hg and the mercury mass was calculated by the dilution method. Before extracting definitive samples, an efficiency control of the labeled mercury mixture was carried out with the liquid and solid stages of the mercury in the cells. Details on operation, measuring, calculations, and instruments used are included. (auth)

39148 (PRNC-135, pp 383-6) NUCLEAR TECHNIQUES IN THE MEXICAN TEXTILE INDUSTRY. Archundia, C.; Navarrete, M.; Islas, C. (Universidad Nacional Autonoma de Mexico, Mexico City). (In Spanish).

From Radiation and isotope technology in Latin American development.

Radioisotope applications in the textile industry are quite varied. Despite the fact that cotton cloth is widely used in Mexico and its manufacture is one of the country's main industries, nuclear techniques have not yet been used to improve processes or investigate new methods in different phases of production. In an attempt to find other uses of interest to the economy or quality control in the Mexican textile industry, UNAM's Nuclear Laboratory has begun to try to establish very simple techniques with possible immediate application, with a minimum of specialized equipment, so as to later become involved in research which requires larger investment and affects a broader spectrum of the industry. Attempts have been made to solve the problem of excess chlorine in bleached cloth before designs are printed on the cloth. Utilizing the great sensitivity of the reaction between chlorine and silver ions, we have achieved a radiometric titration with ^{110}mAg which permits measurement of very small concentrations of the chlorine ion in solution. By means of this procedure, it is possible to establish a norm of quality which is expressed numerically in terms of counts per minute, which can be adopted as the criterion for each company which prints patterns on previously bleached cloth with active oxidants which contain chlorine. (auth)

39149 (PRNC-135, pp 387-96) INDUSTRIAL APPLICATIONS OF RADIOISOTOPES AT INSTITUTO DE ENERGIA ATOMICA IN SAO PAULO. Sanchez, Wladimyr (Instituto de Energia Atomica, Sao Paulo (Brazil)). (In Spanish).

From Radiation and isotope technology in Latin American development.

Industrial applications of radioisotopes at the Institute of Atomic Energy at Sao Paulo, Brazil, are described and include: gammagraphy; gamma-ray scattering soil density meter; autoradiography; piston ring wear in automotive engines using ^{59}Fe; and radioactive method in streamflow measurements. (auth)

39150 (PRNC-135, pp 399-410) ISOTOPES INFORMATION CENTER. Baker, P. S. (Oak Ridge National Lab., Tenn.).

From Radiation and isotope technology in Latin American development.

The ORNL Isotopes Information Center, operated for the U. S. Atomic Energy Commission, is concerned with isotope production and isotope applications—primarily in those areas supported by the USAEC's Division of Isotopes Development. Industrial uses in gaging and tracing, process radiation development, food irradiation, and source and isotopic power development fall within the scope of the Center, plus peripheral coverage of such areas as biology, medicine, agriculture, and education. The Center publishes the quarterly technical progress review, "Isotopes and Radiation Technology," which consists of review articles covering production and utilization of isotopes, as well as appropriate topical brochures. Technical information and bibliographies are also provided, as responses to inquiries, in those areas within scope. Indexing and retrieval involves both a random-access, visual system and an IBM-360/50 computer—the former for browsing and quick, on-the-spot searches, the latter for bibliographic listings. About 650 categorizing (keyword) terms are used for identification of in-scope material. Recovery is based on combining these terms appropriately as part of the search strategy. Illustrations of typical Latin American work in the nuclear application field will be presented. Output from the

Center, free or very nominally priced, comes under several categories: state-of-the-art reviews of various areas of isotope applications; bibliographic compilations, for example, covering the irradiation of foods; publication and/or editing of special reports, brochures, conference proceedings, and translations; and replies to requests for information. (auth)

39151 (PRNC-135, pp 411-18) STUDY ON DISTRIBUTION OF RESIDENCE TIME IN A CEMENT PLANT. Castro, J. O. N. M.; Aun, P. E.; Maestrini, A. A.; Bandeira, J. V. (Minas Gerais Univ., Belo Horizonte (Brazil). Instituto de Pesquisas Radioativas).

From Radiation and isotope technology in Latin American development.

Radioactive tracers are worth consideration in research aimed at obtaining information about essential characteristics of material movement of most industrial equipment. The technique of sudden addition of the tracer, followed by the determination of the concentration-time ratio at the apparatus output, supplies information about the mean residence-time, dispersion, recirculation and so on. A study on the distribution of residence times in a clinker mill with successive recirculations of the material is presented. The tests with radioisotopes employed the irradiated clinker itself as tracer. The flow rate of the mill is about 24 metric tons/hr. The clinker residence-time and the percentage of recirculated material are determined. A model that represents the performance of the apparatus is constructed. (auth)

39152 (PRNC-135, pp 475-80) AN APPLICATION OF THE NEUTRON REFLECTION TECHNIQUE TO THE ANALYSIS OF A LARGE PETROLEUM CRACKING TOWER. Sasscer, Donald S.; Pedersen, Knud B. (Puerto Rico Nuclear Center, Mayaguez).

From Radiation and isotope technology in Latin American development.

The neutron reflection technique was used with success in analyzing a large petroleum cracking tower at the Commonwealth Oil Refining Company in Puerto Rico. The column has been operating at less than designed efficiency since its inception and the company wished to know if there were some way to determine whether any of the trays were missing, dislocated or collapsed, and in general to check the internal configuration of the column by a method which would be nondestructive and which would not hinder the operation or production of the column. (auth)

39153 URANIUM ENRICHMENT INDUSTRY. Avery, D. G.; Kehoe, R. B. (United Kingdom Atomic Energy Authority, Risley, Eng.). Atom (London); 164: 120-30(Jun 1970).

A survey of the historical background of isotope separation and uranium enrichment is given. Four processes of uranium enrichment are discussed; the centrifuge method, the electromagnetic (calutron) method, the thermal diffusion method, the gas diffusion process. The capacity of the present day gas diffusion plants in USA, UK, France, Russia and China are considered. A simplified treatment of the diffusion process is given which enables the main design and optimization characteristics to be identified. Membrane development is reviewed and the difficulties of plant design when dealing with UF_6 considered. The nozzle process and the centrifuge method are examined and their economics discussed. The growing demand for uranium enrichment in Europe is considered in the light of the tripartite agreement. (UK)

39154 THERMAL BARRIER SYSTEM. (to Sanders Nuclear Corp.). British Patent 1,198,861. 15 Jul 1970. Priority date 27 Jun 1966, United States.

A garment for use as a thermal barrier incorporating a heat source of the flameless exothermic type and a closed circuit system for circulating warm fluids is described. A nuclear heat source can be used with the garment. (J.R.D.)

39155 SIDONIE, THE NEW ELECTROMAGNETIC ISOTOPE SEPARATOR AT ORSAY. PART II. PERFORMANCES. Alexandre, K.; Camplan, J.; Ligonniere, M.; Meunier, R.; Sarrouy, J. L.; Smith, H. J.; Vassent, B. (CNRS, Orsay, France). Nucl. Instrum. Methods; 84: 45-54(1970).

Separations of rubidium, xenon and mercury are described. We discuss how to reduce "gas contamination." A high efficiency gas collector which has been used for several tens of milligrams is described. The mercury collector, derived from the xenon collector, is such that "gas contamination" can be totally avoided. A figure of merit of our separator is obtained plotting those enhancement factors which are not affected by "gas contamination" versus the relative mass difference. (auth)

39156 SIDONIE, THE NEW ELECTROMAGNETIC ISOTOPE SEPARATOR AT ORSAY. PART I. DESIGN AND CONSTRUCTION. Camplan, J.; Meunier, R.; Sarrouy, J. L. (CNRS, Orsay, France). Nucl. Instrum. Methods; 84: 37-44(1970).

A new electromagnetic isotope separator designed for the separation of transplutonium elements as well as for the preparation of extremely pure samples of stable isotopes is described. The analysing magnet is a sector type with inhomogeneous field ($n \approx 0.5$). As a consequence the dispersion and the transmission are high. Shims have been added which allow a wide mass range to be focused simultaneously. Correcting profiles, set on the entrance face of the magnet, decrease its radial aberration to about 0.2 mm. With a 7 mA beam, the intensity distribution at the focus, obtained with the improved magnet and a new electrode geometry, is such that about 90% of the intensity passes through a 1 mm wide slit. A liner is enclosed inside the vacuum chamber in order to facilitate the decontamination or the recovery of expensive materials. Plastic bags can be adapted to all openings so as to avoid contaminating external surfaces of the separator. (auth)

39157 AN ION-OPTIC METHOD FOR THE PREPARATION OF THIN RADIOACTIVE SOURCES AT HIGH YIELD. Leon, J.; Steiger-Shafrir, N. H. (Technion-Israel Inst. of Tech., Haifa). Nucl. Instrum. Methods; 84: 102-8(1970).

The use of an electrostatic ion-optic method for the preparation of very thin radioactive sources at high yield is described. The merits of the procedure are demonstrated for a thin ^{228}Th source by two different methods: (1) the measurement of the fwhm of the alpha-peak; (2) the determination of the median range of the ^{224}Ra alpha-decay recoils in hydrogen gas. For a 0.15 μCi source of ^{228}Th, a resolution (fwhm) of better than 13 keV was obtained in the alpha-peak using a Si-solid state detector. (auth)

39158 LONG RANGE PLANNING MODEL OF THE USAEC GASEOUS DIFFUSION PLANT. Stone, Henry (Union Carbide Corp., Oak Ridge, Tenn.)· de la Garza, A.; Hoglund, R. L. Nucl. Appl. Technol.; 9: 376-95(Sep 1970).

A computer model of the existing and possible new USAEC gaseous diffusion plants (GDP) has been developed. The model has been combined with a nonlinear optimization method which permits optimum long range operating plans to be generated. A description of the model is presented with examples of its use in simulation and in generation of optimal long range plans. (auth)

39159 USE OF RADIOACTIVE ISOTOPES IN RADIOISOTOPIC POWER SOURCES. Vdovenko, V. M. Radiokhimiya; 12: 204-22(1970). (In Russian).

The properties of various radioisotopes for use in power sources are reviewed. Marine, surface, and space power sources developed by various countries are tabulated. (R.V.J.)

39160 ATOMIC ENERGY IN INDUSTRY. A GUIDE FOR TRADESMEN AND TECHNICIANS. Meyer, Leo A. Chicago; American Technical Society (1970). 128p.

The volume is written for readers who have no special training in mathematics, physics, or chemistry. Chapters are included on atomic energy at work, the atomic age begins, nature's engine, harnessing atomic power, radioactivity, measuring radiation, radiation effects, and radiation protection. (J.R.D.)

39161 COOPERATION FOR THE ENRICHMENT OF URANIUM WITH GAS CENTRIFUGES. THE GERMAN-BRITISH-DUTCH TREATY OF ALMELO. Schmidt-Kuester, W. J. Atomwirt., Atomtech.; 15: 290-2(Jun 1970). (In German).

In March, 1970, a preliminary treaty was signed between Great Britain, Holland, and Germany, which concerned cooperation and exchange of confidential information concerning enrichment of uranium using gas centrifuges. After one year, the preliminary treaty will be replaced by a final one following ratification by the three parliaments. Organization of the trinational arrangement is described using a chart. Within a few years, pilot plants with a total separation capability of 350 tons/year will be in operation. One of these with 200 tons/year will be located in England, another one with 100 tons will be located in Holland, and location of the third one will be decided at a later date. Each installation will use various types of centrifuges and equipment; however, at the end of a trial period, a unified concept for final production plants will be developed. Other articles of the treaty govern economic and financial aspects, safety provisions ensuring peaceful use, and the settlement of legal discrepancies between the participating nations. (H.B.G.)

39162 NUCLEAR ELECTRICAL POWER SOURCE FOR USE WITHIN THE BODY. Gatt, F. C. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Australas. Bull. Med. Phys. Biophys.; No. 45, 3-9(1 Aug 1970).

A proposed radioisotopic power source is described which may replace some of the low power conventional batteries. In this type of power source a radioisotope is placed adjacent to a p-n junction. Beta particles emitted from the radioisotope create electron-hole pairs in the junction allowing a current to flow

under the influence of a voltage gradient. The candidate isotopes are discussed together with factors influencing their choice, for example: the type and energy of the emitted particle, the half-life and toxicity of the isotope and production of secondary radiations. The criteria involved in choosing a suitable p-n junction are briefly covered. Bremsstrahlung x-ray generation in the power source and its shielding are discussed and limiting values of the dose rate to the surrounding tissue are given. The expected electrical output is 200 microwatts at 5 volts. Uses for such a power source and a short resumé of some work done in other countries engaged in this field are included. (auth) (Australia)

Materials Testing

Refer also to abstracts 39103, 39104, 39107, 39109, 39117, 39207, 39244, and 39629.

39163 (CEA-CONF-1530) NEUTRON RADIOGRAPHY. Farny, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 4 Mar 1970. 20p. (In French). (CONF-700320-1). Dep. CFSTI (U. S. Sales Only).

From Meeting on Nondestructive Testing, Paris, France.

Neutron radiography is viewed as a technique of nondestructive testing complementary to x- and γ-radiography technique. Indeed, the contrasts obtained in the study of the same material are quite different in neutron radiography and radiography. The various parts of a neutron radiography unit are analyzed. The source is either a reactor or a radioisotope source or an accelerator. It is an ejected neutron beam in case of inactive sample analysis for industry. The environmental shielding from the ejected beam is provided with a Bi filter. The unit near a reactor is immersed when active material analysis is under consideration. For detection, the neutron information has to be transformed into α, β, and γ particles able to impress a radiographic film, by means of a converter. In the direct technique (Gd converter), the film is directly impressed in the indirect technique (Dy, In converter) activation takes place first and the film is then impressed in the processing laboratory. Neutroscopy is a modification of the direct technique with a display on a ZnS screen. (auth) (France)

39164 (CEA-CONF-1540) ULTRASONIC AUTOMATIC TESTING METHODS OF WELDS USED AT SACLAY-S.T.A. Chretien, J. F.; Prot, A. C.; Huard, J. J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 12p. (In French). (CONF-700613-1). Dep. CFSTI (U. S. Sales Only).

From 6th International Conference on Non-Destructive Testing, Hannover, Germany.

Specific automatic testing methods, giving in each case a map of the weld, were designed. Some applications of these methods are described, e.g., automatic tube-to-tube plate welding test with a special device allowing the test to be made inside the tube by means of a mirror for the ultrasonic beam, and automatic heavy plate electron-beam welding test using immersion and contact techniques. By use of quite simple devices and without really skilled operators, field testing is made possible, which gives the welder a clear representation in the form of a map, which may be compared to a film for radiographic testing. (auth) (France)

39165 (CEA-CONF-1543) INDUSTRIAL APPLICATIONS OF NEUTRON RADIOGRAPHY: EQUIPMENT AND SOURCES. Farny, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 12p. (In French). (CONF-700613-2). Dep. CFSTI (U. S. Sales Only).

From 6th International Conference on Non-Destructive Testing, Hannover, Germany.

The neutron ejected beam units used for industrial neutron radiography on Triton and Melusine research reactors are presented. Scheme of the standard beam (filter, collimator, shielding) and also of the whole neutron radiography unit installed on the Triton reactor are given. The performances obtained in neutron radiography technique for the various materials studied are reviewed. The possibilities of extension of the techniques presently used towards neutroscopy and leakage neutrons use are examined. (auth) (France)

39166 (DP-Report-118) TESTS ON STAGE 1 OF THE 37-WAY SELECTOR VALVE PROTOTYPE. Project DRAGON. Nullens, G. C.; Day, M.; Aarset, B. (Atomic Energy Establishment, Winfrith (England)). Nov 1962. 22p. Dep. CFSTI.

The results of the various tests performed on the Stage 1 prototype of the 37-way selector valve are given. The test rig included the final valve selecting and operating mechanism, but only 4 valves— the non-return valve and 3 ordinary 3-way valves. The tests were carried out in purified helium, and the leak rate through the valves was recorded from time to time during the 2,100 operations. Later on, tests will be done on the final prototype selector valve unit, comprising all 37 3-way valves and one non-return valve. (auth)

39167 (NLCO-1059) EVALUATION OF AN EDDY-CURRENT TESTER FOR DETECTING SEAMS IN ROLLED URANIUM RODS. Neu, C. A. (National Lead Co. of Ohio, Cincinnati). Jun 1970. Contract AT(30-1)-1156. 22p. Dep. CFSTI.

A Roto-Bar-Tester was evaluated and found capable of detecting and measuring seams in rolled uranium rods. The instrument contains probes which rotate about the rod while the rod is moved longitudinally through the machine. (auth)

39168 (PRNC-135, pp 495-506) TESTING CAST-IN-PLACE CONCRETE PILES BY RADIOISOTOPE METHODS. Preiss, K. (Negev Inst. for Arid Zone Research, Beersheba (Israel)).

From Radiation and isotope technology in Latin American development.

When casting a pile in situ, the concrete may segregate, or soil may fall into the pile. The pile cap may then settle under load. The use of gamma ray transmission and neutron backscattering methods to check that the concrete is correctly cast is described. The gamma ray transmission method is usually preferred, and the effects of various parameters on the accuracy of this method are evaluated. (auth)

39169 METHOD AND DEVICE FOR THE NON-DESTRUCTIVE CONTROL OF NUCLEAR FUELS. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,197,099. 1 Jul 1970. Priority date 25 Aug 1967, Germany.

The method is based on irradiation of bodies to be tested for fuel content, using low energy neutrons, and measuring the fast neutrons released by fission. The prompt gamma radiation pulses emitted by the fuel after neutron capture are also measured and the (n,γ) coincidences are subtracted from these pulses. Monoenergetic collimated neutron beams are used in the tests. (J.R.D.)

Radioactive Material Handling

Refer also to abstracts 38764, 38988, 39038, 39127, 39169, 39459, 39677, and 41035.

39170 (DP-Report-129) SOME ENGINEERING PROBLEMS ASSOCIATED WITH THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Coast, G. (Atomic Energy Establishment, Winfrith (England)). Dec 1962. 20p. Dep. CFSTI.

In order to maintain the activity in the primary circuit at a low level it is necessary to remove the bulk of the fission products which are released by means of a clean-up plant. This plant is inevitably highly active and special problems of sealing and remote operation have to be considered. (auth)

39171 (KFK-908) RELATIONS BETWEEN RELEVANT PARAMETERS FOR INSPECTION PROCEDURES. Avenhaus, R.; Gmelin, W.; Gupta, D.; Winter, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Mar 1970. 53p. (CONF-690826-3). Dep. CFSTI (U. S. Sales Only).

From Conference on Systems Analysis, Vienna, Austria.

In the framework of the analysis of an instrumented safeguards system the problem of the establishment of a material balance in a nuclear facility is treated. The case of a sequence of inventory periods is considered. Here, a number of parameters are important, for example the way of estimating the inventory at the beginning of a new inventory period, the different possibilities for definition of the probability of detection, the strategy of the operator, and the concept of detection time. These questions are treated analytically, and a reprocessing plant and a fabrication plant are simulated on the computer. With the help of these simulations the influence of the choice of the starting inventory and the strategy of the operator on the probability of detection and on the detection time are investigated. (auth)

39172 (LA-4457) NUCLEAR SAFEGUARDS RESEARCH AND DEVELOPMENT PROGRAM STATUS REPORT, JANUARY-APRIL 1970. (Los Alamos Scientific Lab., N. Mex.). Jun 1970. Contract W-7405-eng-36. 41p. Dep. CFSTI.

Research and development are reported on neutron interrogation and nondestructive assay of fissionable materials, passive gamma radiation methods, passive neutron methods, nuclear instrumentation and apparatus development, computational and data acquisition facilities, mobile assay laboratory, accelerators, neutron source development, and facility development. (J.R.D.)

39173 (ORNL-4446, pp 9-11) DISPOSAL BY HYDRAULIC FRACTURING. de Laguna, Wallace (Oak Ridge National Lab., Tenn.).

Waste disposal injections of a total volume of about 1,500,000 gal of water and slurry, containing nearly a quarter of a million curies, has been pumped down the disposal well. More observation and rock-cover monitoring wells are being added. Drilling into the waste-filled fractures deep underground raises minor problems of contamination. The initial work in New York State suggests that the experiments there can be carried out much as planned, although some minor modifications will be required. (auth)

39174 (ORNL–4446, pp 12-16) DISPOSAL IN NATURAL SALT FORMATIONS. Bradshaw, R. L.; Blomeke, J. O.; Boegly, W. J. Jr.; Empson, F. M.; Hodge, T. W. Jr.; Houser, B. L.; Lomenick, T. F.; McClain, W. C.; Starfield, A. M.; Wyrick, H. J. (Oak Ridge National Lab., Tenn.).

The program for the disposal of radioactive wastes in salt mines is discussed. The effort in this program is directed toward the establishment of an actual high-level waste repository capable of accepting all of the power reactor wastes until about the end of the century. This effort is currently along three different lines: the development of a computer program modeling the long-term deformational behavior of mine pillars of different designs under the influence of stress, elevated temperatures, and thermal gradients; the development of a mine management program capable of defining the spacing required between successive cans of waste; and the preparation of a report providing information on where the disposal facility should be located, how big it should be, and when it should be ready for operation. Other work is continuing, including the preparation of a final comprehensive report on the demonstration experiment, Project Salt Vault, and the examination of rock types other than salt which might be usable for radioactive waste disposal. This latter work has been concerned recently with the determination of the effects of heat, stress, and radiation on the deformation of limestone. (auth)

39175 (ORNL–4446, pp 17-22) ENGINEERING, ECONOMIC, AND SAFETY EVALUATION. Jacobs, D. G.; Cowser, K. E.; Gera, Ferruccio; O'Neill, R. V.; Sealand, O. M. (Oak Ridge National Lab., Tenn.).

The amount of transuranic nuclides anticipated in the wastes from processing of reactor fuels is such that it must be considered in the management of such wastes. The major potential hazard seems to be associated with inhalation as the exposure mode, and containment times on the order of hundreds of thousands of years would be required. Rehandling of the waste, especially after the container and its contents had lost integrity, would be hazardous to operating personnel. In view of the extremely long containment times required, consideration of long-term geologic alterations in the earth's crust is under study. Some examples of the rates of these changes are given. Many exposure pathways must be investigated to estimate the potential internal dose to population groups from radionuclides that may be released by nuclear facilities. This involves consideration of foods consumed by man as well as ingestion of water and inhalation of air. A preliminary version of the computer program PATHWAY has been formulated to trace the movement of ^{131}I, ^{137}Cs, and ^{90}Sr through environmental food chains to man. (auth)

39176 (ORNL–tr–2348) SHIPPING OF IRRADIATED FUEL ELEMENTS FROM FAST BREEDER REACTORS. Boehme, G.; Gast, K.; Gupta, D.; Hagen, A.; Kraemer, R.; Schikarski, W.; Schmidt, W.; Sebold, G.; Wiese, H. W.; Zimmermann, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Translated for Oak Ridge National Lab., Tenn., from report KFK–666. 186p. Dep. CFSTI.

This paper was abstracted from the original language and appeared in NSA as 24: 20968.

39177 (SC–DC–70–4947) TRUST: TAMPER-RESISTANT UNATTENDED SAFEGUARDS TECHNIQUES. A Joint Canada/USA Progress Report. McManus, J. G. (Atomic Energy Control Board, Ottawa (Ontario)); Engel, A. V. Jr. (Sandia Corp., Albuquerque, N. Mex.). [1970]. 19p. (CONF–700701–2). Dep. CFSTI.

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany.

TRUST is a joint Canada/USA safeguards research and development project. The objectives of this project are to develop and evaluate prototype instrumentation, unattended and secure, which is applicable to the safeguarding of power reactors and other nuclear facilities and to test tamper-resistant techniques and devices in an operating power reactor. The Nuclear Power Demonstration reactor at Rolphton in Canada was selected as the site for the field test of the developed instruments and techniques. The design guidelines and preliminary design considerations of the project are described briefly. The instruments designed for installation at the NPD reactor and methods for their interconnection and operation are described. The generation of information is described, and its flow is traced from sensors, along transmission paths, and to storage and recovery modules until the information is available for use by a safeguards inspector. The techniques developed to protect instruments and recording stations are described. For small volumes of the order of 1 cubic foot, especially prepared glass containers that will indicate unauthorized entry or influence are used. A large volume, of the order of 600 cubic feet, containing the central recording station is protected by a radio frequency monitor which detects unauthorized entry. Flow of information along unprotected transmission lines between secure containers is protected by simple yet effective coding techniques. The test results available are discussed. (auth)

39178 (WASH–1147) PROCEEDINGS OF THE AEC SYMPOSIUM ON SAFEGUARDS RESEARCH AND DEVELOPMENT, LOS ALAMOS SCIENTIFIC LABORATORY, LOS ALAMOS, NEW MEXICO, OCTOBER 27-29, 1969. (Office of Safeguards and Materials Management (AEC), Washington, D. C.). 197p. (CONF–691045). Dep. CFSTI.

Separate abstracts were prepared for each of the 24 papers presented at the symposium. (M.C.G.)

For abstracts of individual papers see: 39179–39202.

39179 (WASH–1147, pp 2-5) AN OVERVIEW OF U. S. DOMESTIC SAFEGUARDS. Crowson, Delmar L. (Office of Safeguards and Material Management (AEC), Washington, D. C.).

Progress in safeguards is reported under the following topics: umpire laboratory program, nondestructive testing, resident inspection, transportation safeguards, information systems, international cooperation, regulatory actions, and the future. (M.C.G.)

39180 (WASH–1147, pp 7-15) SAFEGUARDS CONTROLS, LICENSING AND REGULATING PRIVATE NUCLEAR INDUSTRY. Wischow, R. P. (Division of Nuclear Materials Safeguards (AEC), Washington, D. C.).

Measurements and statistical controls for a safeguards program are discussed. The five components of the material balance are totals of individual item measurements that comprise beginning inventory, receipts, shipments, normal operational losses, and ending inventory. Sampling errors and inventory verification are discussed. (M.C.G.)

39181 (WASH–1147, pp 17-20) SAFEGUARDS ACTIVITIES WITHIN INDUSTRY. Schubert, A. E. (General Electric Co., San Jose, Calif. Nuclear Energy Div.).

Safeguards activities in the areas of fuel fabrication, power reactor operation, and fuel reprocessing are discussed. Safeguards records and reporting requirements, plant security, transportation, and analysis methods are discussed. (M.C.G.)

39182 (WASH–1147, pp 25-6) ASSESS THE THREAT OF HI-JACKING BY THE MAFIA. Bellino, C. (Wright, Long and Co., Washington, D. C.).

The importance of finding out where the transportation of fissionable material is vulnerable to theft or diversion and of eliminating or reducing the threat is discussed. (M.C.G.)

39183 (WASH–1147, pp 28) SAFEGUARDS PROGRAM FOR TRANSPORTATION. Boyd, George F. (Tri-State Motor Transit Co., Joplin, Mo.).

Features of the program include: rigid driver qualifications, training programs, specially designed trailers, and singular responsibility for the shipment. (M.C.G.)

39184 (WASH–1147, pp 30-1) TRAFFIC MANAGEMENT IN NUCLEAR SAFEGUARDS. Edlow, S.

Strategic material in a transportation environment is discussed. Inefficiencies of the transportation industry and carrier responsibility are considered. (M.C.G.)

39185 (WASH–1147, pp 33-8) HANDLING OF RADIOACTIVE MATERIALS IN MOTOR CARRIER SERVICE. Kaye, R. A. (Division of Construction (AEC), Washington, D. C. Transportation Management Branch).

Transporting strategic nuclear materials by common carrier is discussed. Emphasis is placed on loading, terminal operations, and unloading. (M.C.G.)

39186 (WASH–1147, pp 40-8) PHYSICAL PROTECTION STANDARDS. Hightower, E. D. (Division of Security (AEC), Washington, D. C.).

Physical protection policies in testing and approving physical security devices are considered. Protective barriers, intrusion alarm systems, repositories, and access controls were studied. (M.C.G.)

39187 (WASH–1147, pp 50-7) UNATTENDED TAMPER-RESISTANT SAFEGUARDS INSTRUMENTATION: A PROGRESS

REPORT. McManus, J. G. (Atomic Energy Control Board, Ottawa (Ontario)); Engel, A. V. Jr. (Sandia Labs., Albuquerque, N. Mex.).

The objectives of the program are to develop and evaluate prototype instrumentation (unattended and secure), which may be applicable to the safeguarding of power reactors and other nuclear facilities, and to test tamper-resistant/tamper-indicating techniques and devices in the severe environment of an operating power reactor. Instrumentation design is described and techniques discussed. (M.C.G.)

39188 (WASH-1147, pp 61-2) U. S. SYSTEM STUDIES. Williams, J. (Office of Safeguards and Materials Management (AEC), Washington, D. C.).

The role of the systems analyst in developing an effective safeguards system is described. The programs formulated to attain these goals and problems identified in the studies are discussed. (M.C.G.)

39189 (WASH-1147, pp 64-5) BATTELLE-NORTHWEST SAFEGUARDS SYSTEMS ANALYSIS. Schneider, R. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The measurement aspects of material balance accounting and the effectiveness of material control systems are discussed. Random and systematic errors are considered. The promptness with which a system can detect a loss and the concept of verification are considered. (M.C.G.)

39190 (WASH-1147, pp 67-8) MEASUREMENTS AND NUCLEAR ACCOUNTABILITY METHODS. Suzuki, George (National Bureau of Standards, Washington, D. C.).

The role of measurements in safeguards accountability is discussed. Subprocess material flow records and their uses are described. (M.C.G.)

39191 (WASH-1147, pp 70-3) DEVELOPMENT OF AN AGENCY PROGRAMME FOR SAFEGUARDS SYSTEMS ANALYSIS. Hough, Gordon (International Atomic Energy Agency, Vienna (Austria). Dept. of Safeguards and Inspection).

The evaluation of safeguards systems analysis is reviewed. Development of the program and its execution are discussed. (M.C.G.)

39192 (WASH-1147, pp 80-3) SAFEGUARDS SYSTEMS ANALYSIS AND COLLABORATION WITH NUCLEAR INDUSTRIES. Gupta, D. (Kernforschungszentrum, Karlsruhe (West Germany)).

Systems analyses are discussed along with results of a safeguards exercise carried out at a Pu fabrication plant. Systems analytical considerations requiring industrial collaboration are discussed. (M.C.G.)

39193 (WASH-1147, pp 85-94) SOME ASPECTS OF SAFEGUARDS IN THE UNITED KINGDOM. Morgan, F. (Atomic Weapons Research Establishment, Aldermaston (England)).

Systems analysis, significance criteria for MUF (material unaccounted for), and current areas of development are discussed. The policy adopted was of verifying wherever possible the methods and techniques normally used in the factories by the use of portable equipment. (M.C.G.)

39194 (WASH-1147, pp 96-108) REVIEW OF PASSIVE METHODS. Rasmussen, Norman C. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering).

Passive methods are those that use the spontaneously generated nuclear radiations from an isotope to determine its presence quantitatively. Alpha, gamma, and neutron methods are described. Applications to measurements on fuels and wastes are considered. (M.C.G.)

39195 (WASH-1147, pp 110-33) LOS ALAMOS SCIENTIFIC LABORATORY SAFEGUARDS RESEARCH AND DEVELOPMENT PROGRAM. Keepin, G. R.; Augustson, R. H.; Walton, R. B. (Los Alamos Scientific Lab., N. Mex.).

Physical assay methods should be nondestructive. The nondestructive methods can be divided into two main categories: passive assay and active interrogation. Examples of each are described. Analysis of fuels and of scrap is reported. New technique development is discussed. (M.C.G.)

39196 (WASH-1147, pp 135-43) NONDESTRUCTIVE MEASUREMENTS OF NUCLEAR MATERIALS USING AN ELECTRON LINAC. Bramblett, R. L. (Gulf General Atomic, Inc., San Diego, Calif.).

Photonuclear techniques are being developed for measurements of nuclear materials. Samples are irradiated with radiation from an electron accelerator. Characteristic nuclear reactions are produced and the resulting reaction radiations are measured with detector systems. Analysis of assay data, nondestructive assay of bulk samples, and a transportable assay system are discussed. (M.C.G.)

39197 (WASH-1147, pp 145-52) THE USE OF NEUTRONS FROM PHOTOINDUCED REACTIONS IN THE GGA SAFEGUARDS ASSAY SYSTEM. Gozani, T. (Gulf General Atomic, Inc., San Diego, Calif.).

Photofission as a method of determining the presence of fissile material is discussed. The delayed neutron yield is used for determination of the total amount of fissile material. The various isotopes can be determined from the dependence of yield from photoinduced reactions on the type of isotope. (M.C.G.)

39198 (WASH-1147, pp 154-9) A REVIEW OF THE MORE IMPORTANT NON-DESTRUCTIVE METHODS UNDER CONSIDERATION FOR SAFEGUARDS PURPOSES AT THE KARLSRUHE RESEARCH CENTER. Gupta, D. (Kernforschungszentrum, Karlsruhe (West Germany)).

Main research emphasis was on the development of indirect assay methods for unirradiated fuel pins and subassemblies containing uranium and/or plutonium. Methods studied include: calorimetry, lead pile spectrometer, personnel γ-lock, reactivity method, and n,γ reactions. (M.C.G.)

39199 (WASH-1147, pp 164-5) SAFEGUARDS FROM A POWER PRODUCER'S VIEWPOINT. Behnke, W. G. (Commonwealth Edison Co., Chicago, Ill.).

Safeguards techniques at a power reactor site and for reactor fuels are discussed. It is postulated that the most effective safeguards system will make maximum use of the controls normally applied for financial purposes. (M.C.G.)

39200 (WASH-1147, pp 167-8) SPECIAL NUCLEAR MATERIAL MEASUREMENTS. Miller, Herman (National Nuclear Corp., Palo Alto, Calif.).

Government and industry requirements, some economic factors, and the instrumentation and techniques presently available and needed are discussed. (M.C.G.)

39201 (WASH-1147, pp 170-1) SAFEGUARDS DURING REPROCESSING. Newman, Robert I. (Allied Chemical Nuclear Products, Inc., Florham Park, N. J.).

Methods proposed for nondestructive determination of the fissile content of spent fuel, prompt instrumented assay of liquid streams for fissile material, and improved sampling methods are discussed. (M.C.G.)

39202 (WASH-1147, pp 173-7) SAFEGUARDING PLUTONIUM OR PLUTONIUM-BEARING FUEL. Povejsil, D. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.).

A suggested management approach to the plutonium safeguards problem and the timing required for solutions to the plutonium problem in fuel fabrication facilities are discussed. (M.C.G.)

39203 ELECTROLYTIC DECONTAMINATION OF RADIOACTIVELY CONTAMINATED EQUIPMENT. Raviv, Szmuel; Rabinovitz, Elsa; Malkiely, Shimon (to Israel Ministry of Defence). U. S. Patent 3,515,655. 2 Jun 1970. Filed 15 Sep 1967.

Removal of radioactive contamination from various equipment is described. The equipment was connected as a cathode into an electrolytic circuit in which the electrolyte was an aqueous 1 to 9N nitric acid solution. (auth)

Vacuum Engineering

Refer also to abstract 39619.

39204 REVIEW OF SOME RECENT VACUUM STUDIES (RELATED TO PUMPS AND ION BEAM SPUTTERING SYSTEMS). Holland, L. (Edwards High Vacuum International Ltd., Crawley, Eng.). Vacuum; 20: 175-92(May 1970).

The performance of instruments or process apparatus operating under vacuum or reduced pressure can critically depend on the environment produced by the exhaust system. This is demonstrated when discussing the diverse subjects selected for review which cover pumping devices and plasma and ion beam systems. The topics dealt with on pumps are oil decomposition in rotary mechanical pumps and the effect of gas pressure and sorbent traps on organic backstreaming; the fragmentation of diffusion pump fluids in electron impact ion source and the comparative stability of the polyphenylethers; and the pumping of inert and active gases by sputter-ion pumps with tantalum and titanium cathodes. These are followed by discussion of the problems encountered when bom-

barding dielectric materials with energetic particles to prevent charge accumulation and polymer growth. Low pressure plasma systems are described for surface cleaning and thin film sputtering which localize ionization and prevent interaction with the pumps. In conclusion, ion beam systems for specimen thinning and ion scattering studies are discussed. (auth) (UK)

39205 VACUUM SYSTEM PERFORMANCE OF SPACE ENVIRONMENT SIMULATOR. Asai, Jun-ichi; Sasaki, Tatsuo; Furukawa, Masao; Saito, Hiromu; Iide, Senjiro (National Space Development Agency, Tokyo). Denpa Kenkyusho Kiho; 16: No. 82, 10-22(Jan 1970). (In Japanese).

Space environment simulator was constructed in 1968 to investigate the thermal vacuum performance of artificial satellites. The simulator consists of two chambers, main and sub chambers, made for testing a satellite and its components. The size of the main chamber is 4.9m in length and 1.8m in diameter. The vacuum pumping system consists of a helium cryopump, liquid nitrogen heat sink, 32-inch oil diffusion pump, and roughing vacuum pump unit consisting of a blower and mechanical high-vacuum pump. The ultimate pressure reached was 2×10^{-9} torr in 4 hours. The size of the sub chamber is 96cm in length and 60cm in diameter. The vacuum pumping system is of oil-free system made up of helium cryopump, liquid nitrogen heat sink, sputter-ion pump, and four sorption pumps. The ultimate pressure reached 2.7×10^{-10} torr in 4 hours. Cryopumping is accomplished with a 150-watt capacity gaseous helium refrigeration unit circulating through helium panels. These are placed behind liquid nitrogen baffles, and helium panels are supplied with gaseous helium at 10°K to maintain the maximum temperature of 15°K. The effective pumping speed of the cryopump was estimated at about 2×10^{-4} (l/sec) in the main chamber and 3.5×10^{-4} (l/sec) in the sub chamber. The effective speed of other pumping units was nearly consistent with calculated values. The comparison of residual gas and vapor patterns recorded with the AMP-3 mass filter gave an interesting cryotrapping phenomenon for uncondensable gases, such as H_2, He, and Ne, during operation and after stopping of cryopumping. Residual gas and vapor molecules were principally H_2O, N_2, CO, $H^{35}Cl$, $H^{37}Cl$, CO_2 and especially O_2 in the main chamber. The vacuum pumping system could be maintained below 10^{-6} torr pressure required for obtaining accurate thermal balance determination of a specimen which has a large outgassing rate, such as 1 torr l/sec in the main chamber and 0.1 torr l/sec in the sub chamber. (auth) (Japan)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 38799, 39118, 39412, and 39525.

39206 (CEA-R-3959) USE OF A SURFACE-BARRIER DETECTOR FOR FISSION-PRODUCT DETECTION BY ELECTRICAL COLLECTION. Lecomte, Pierre; Le Meur, Roger (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1970. 53p. (In French). Dep. CFSTI (U. S. Sales Only).

One method for can rupture detection consists in extracting the fission gases from the cooling liquid of a reactor and in measuring the beta activity of the decay products ionized after electrical collection. A scintillation detector is usually used for measuring the beta activity of the products collected. The possibility of using a silicon surface barrier detector is considered. The energy calibration and the perturbations caused by the presence of a screen are examined in detail. It is found that for the same working surface, the use of a surface barrier detector appears to be more advantageous than a scintillation detector for measurement of fission gases at ambient temperature. (auth)

39207 (IN-1317, pp 233-381) EXPERIMENTAL FACILITIES, TECHNIQUES, AND INSTRUMENTATION. (Idaho Nuclear Corp., Idaho Falls).

ADVANCED TEST REACTOR—noise analysis in, low-frequency digital filter for computer
—in-pile loops for, auxiliary computer system for
AMPLIFIERS—design of high-speed feedback-stabilized
BETA SPECTROMETERS—control and data acquisition computer system for $\sqrt{2}\,\pi$ magnetic
—operation and performance of $\sqrt{2}\,\pi$ magnetic
CADMIUM—burnout of cadmium-113 in shielding for reactor target capsules
COMPUTERS—development at NRTS, June, 1969
DENSITOMETERS—design for automatic evaluation of fuel element plate radiographs
EDDY CURRENT TESTING—equipment for measuring oxide coating thickness on fuel elements
ENGINEERING TEST REACTOR—in-pile loop for, computer instrumentation system for sodium cooled
—cooling system for, improvement in chart readout of water radioactivity monitor in secondary
GAMMA SPECTROMETERS—data analysis for, package of computer programs for
HYDRAULIC PRESSES—development of 100 kbar, for neutron diffraction studies
LEVEL INDICATORS—calibration system for ultrasonic, automatic
—design of liquid nitrogen, for germanium semiconductor detector cryostats
MATERIALS TESTING REACTOR—experimental facilities for, development of neutron beam
—experimental facility for thermal neutron radiography at, development of
NEUTRON BEAMS—spectra measurements in 2 keV, with proton-recoil proportional detector
NEUTRON CHOPPERS—development of correlation, for time-of-flight measurements
NEUTRON CROSS SECTIONS—calculation of, ACSAP code for automatic
NEUTRON SOURCES—development of Very Intense Neutron Source
NEUTRON SPECTROMETERS—calibration and performance of proton-recoil proportional
PLUTONIUM-239—neutron fission at 0.01 to 1.0 eV, cross section measurement using correlation technique
PREAMPLIFIERS—design of high-speed FET
PULSE GENERATORS (ELECTRONICS)—description for simulating germanium detector pulses
RADIATION DETECTORS, ACTIVATION—development of long-term, for integrated neutron flux monitoring
—data analysis method for determining neutron flux spectra
RADIATION DETECTORS, SEMICONDUCTOR (GERMANIUM)—performance of lithium-drifted, for precise measurement of gamma sources
RADIATION DETECTORS, SEMICONDUCTOR (SILICON)—development of surface-barrier, for fissionable material determination by alpha detection
RADIOGRAPHY, INDUSTRIAL—developments in neutron, for inspection of reactor fuels
REACTOR COOLANTS—analysis of water, lithium-drifted germanium gamma spectroscopy
REACTOR FUELS—burnup measurement from neutron resonance parameters
REACTORS, RESEARCH—neutron spectra in CFRMF, (E/T)
—reactivity data for CFRMF
URANIUM-232—neutron polar cross section at 1 to 31 eV, calculation using ACSAP code
X-RAY SPECTROMETERS—efficiency of lithium-drifted germanium and silicon, at 5 to 125 keV (W.H.K.)

General Detectors and Monitors

Refer also to abstracts 39119, 39369, 39394–39396, 40935, and 41063.

39208 (ACRH-1000-190) HIGH RESOLUTION OF RECTILINEAR BRAIN SCANNING: IS IT WORTH THE EFFORT. Gottschalk, Alexander (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill. Dept. of Radiology). [Jan 1970]. 16p. (CONF-700110-2). Dep. CFSTI.

From 2nd Annual Meeting of the Nuclear Medicine Seminar, Miami Beach, Fla.

The brain scanner at Argonne Cancer Research Hospital, consisting of four detectors and high-resolution collimators, is briefly described and compared to the conventional three inch scanner and Anger camera. (W.H.K.)

39209 (AERE-R-6429) ACTIVATION TECHNIQUE FOR THE ABSOLUTE CALIBRATION OF A LONG COUNTER. Adams, J. M.; Ferguson, A. T. G.; McKenzie, C. D. (Atomic Energy Research Establishment, Harwell (England)). Jun 1970. 23p. (EANDC(UK)-124 AL). Dep. CFSTI (U. S. Sales Only). UK 3s. 6d.

An independent activation technique has been developed and applied to the calibration of the Harwell standard long counter in the neutron energy range from 50 to 1300 keV. The method requires only the accurate knowledge of the total strength of sources of two radioactive nuclei, viz., ^{51}Cr and ^{57}Co. The results obtained using this technique are compared with the previous estimations which were based on the hydrogen cross-section. (auth)

39210 (BMBW-FBK-70-6) REAL TIME WHOLE BODY COUNTER-COMPUTER SYSTEM. Koeppe, P. (Freie Universitaet, Berlin (West Germany)). Apr 1970. 283p. (In German). Dep. CFSTI U. S. Sales Only.

Principles, hardware and software of an on-line, real time, whole-body counter–computer-system are described. (auth)

39211 (BNWL-1178) USE OF SOLID STATE DETECTORS FOR ORGAN COUNTING. McConnon, D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jul 1970. Contract AT(45-1)-1830. 13p. Dep. CFSTI.

Results of in vivo measurement of a complex mixture of gamma emitters with conventional whole body or organ counting systems are often unsatisfactory because of the poor resolution of the counting system. The possibility of eliminating this problem by the use of a counting system employing a high resolution solid state detector prompted study of such a system to determine its suitability in measuring amounts of radionuclides in individual organs. The response of a dual crystal Ge(Li) detector to gamma emitters contained in various organ compartments of an anthropomorphic phantom was measured. The study indicated that even though its sensitivity is poor relative to that of conventional organ counting systems, use of a solid state system may yield useful supplemental information for assessment of internal depositions, provided the amount deposited in the organ is sufficiently large, and that the background and counting geometry are controlled. (auth)

39212 (BRH/DEP-70-13) VARIABILITY IN THE AUTOMATIC PROCESSING OF MEDICAL X-RAY FILM. Ferguson, John P.; Schadt, Warren W. (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products). Jun 1970. 33p. CFSTI.

Equally exposed films were developed in 26 automatic processors. Films were developed in 22 of these processors, one film per week for 3 consecutive weeks. The percent standard deviations of the film base-fogs, relative speeds, and average gradients were respectively 18, 12, and 4 percent. Films were developed in the other four processors on a daily basis for a one-month period. During this time, two of the processors required major servicing

because of mechanical and chemical malfunctions. The percent standard deviations of the base-fog for the films developed in these two processors were 39 and 51 percent. For the other two processors, the percent standard deviations in the base-fog were both 11 percent. (auth)

39213 (BRH/DEP-70-14) SIMPLE X-RAY DETECTION INSTRUMENTS FOR TELEVISION SERVICE TECHNICIANS. Stoms, Richard K.; Kuerze, Edward (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products). Jun 1970. 25p. CFSTI.

Simple circuits for detecting x rays by means of a thin (36 mg/cm^2) aluminum-wall organic-quenched cylindrical Geiger-Mueller counter are described. Visible and audio output representing the detector counting rate is presented. A count-rate meter circuit, and a manually switched and an electronic oscillator high-voltage supply are described. Also, a simple circuit and procedure for count-rate calibration of the metered circuit are given. All circuits are readily constructed from commonly available components. (auth)

39214 (CEA-N-1330) AUTOCURRENT NEUTRON DETECTORS WITH FAST RESPONSE. Verdant, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1970. 52p. (In French). Dep. CFSTI (U. S. Sales Only).

The autocurrent thermal neutron detectors usually use β particles emitted by an activated material called emitter and collected by a metallic sheath. Their application range lies in the region of 10^{10} cm^{-1} S^{-1} and the principal advantages are that they are simple, easily accessible, less costly and reliable up to a temperature of 500°C. Their response time is controlled by the period of radioactive isotope formation and as such their application for relative dosimetric measurements is limited. At a neutron flux of 10^{14} cm^{-1} S^{-1} a new type of detector having fast response times was realized. The emitter of this new type was made of a body activated with products having a time period much longer than the previous types. The current supplied by this detector whose emitter is cobalt, originates from Compton electrons produced by γ radiation captured from the reaction $^{59}Co(n,\gamma)^{60}Co$. Its sensitivity was of the order of $(7 \pm 81) \times 10^{-23}$A/nv/cm for an emitter of 1/mm diameter and response time less than a second. The three types of experimental detectors accumulated a flux of 6.10^{20} n/cm^2 without any change in current. The parasitic elements due to γ-radiation of the reactor were less than 5%. (France)

39215 (CEA-R-3844) COLLECTION EFFICIENCY OF CHARGES IN IONIZATION CHAMBERS IN PRESENCE OF CONSTANT OR VARIABLE RADIATION INTENSITY. Decuyper, Jean-Claude (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar 1970. 200p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Faculte des Sciences, Univ. of Grenoble, France.

The theoretical and experimental study of the collection of carriers built up by ionization in standard chambers is made by varying the value of different acting parameters. In the presence of constant ionization intensity and under a D. C. and A. C. voltage, the effect of geometry, recombination, diffusion, and attachment is analyzed. The compensation of thermal neutron D. C. chambers is equally considered. Under a time dependent ionization intensity and D. C. voltage, the effect of recombination on current response and on the collection efficiency of all formed charges is studied, also. (auth)

39216 (CLOR-79/D) PORTABLE TRANSISTORIZED TRITIUM CONTAMINATION MONITOR. Katkiewicz, W.; Jachymek, A. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1969. 9p. (In Polish). Dep. CFSTI (U. S. Sales Only).

A fully transistorized portable tritium contamination monitor using an open ionization chamber was developed. The monitor was applied for surface contamination measurements from the level of 40 pCi/cm^2. The monitor has a temperature drift of 0.5 div/°C, a short term drift lower than 0.5%/min, and a current drain of 1 mA. (auth)

39217 (COO-1726-45) SENSITIVE FAST RESPONSE ELECTRON DETECTOR. Kuswa, Glenn W. (Wisconsin Univ., Madison). [1960]. 6p. Dep. CFSTI.

A miniature scintillation electron detector was developed for use with a small energy analyzer working in the range of .5 to 1000 eV. The gain was 10^4, and the inherent risetime was ~5 nsec, given sufficient input signal. Optical coupling of the signal eliminated ground loops. (auth)

39218 (JINR-P3-5119) TECHNIQUE OF $\bar{\nu}$ MEASUREMENT OF NEUTRON TIME-OF-FLIGHT SPECTROMETER. Ryabov, Yu. V.; Chikov, N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1970. 19p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A large liquid cadmium-loaded scintillation detector, having the efficiency to the fission neutrons of about 90%, is used for measurements of the yield ($\bar{\nu}$) of an average number of prompt neutrons per fission act. (auth)

39219 (KR-139) HIGH-EFFICIENCY COUNTING OF ^{249}Bk BY A LIQUID SCINTILLATION TECHNIQUE. van der Heijden, W. A.; Kraak, W. (Institutt for Atomenergi, Kjeller (Norway). Reactor Centrum Nederland, Petten). Jan 1970. 15p. Dep. CFSTI (U. S. Sales Only).

A liquid scintillation technique for high efficiency counting of ^{249}Bk is described. A detection efficiency of about 93% was obtained. (auth)

39220 (NIRS-8, pp 1-17) PHYSICAL SCIENCES. (National Inst. of Radiological Sciences, Chiba (Japan)).

The development of radiation detectors and dosimeters for nuclear medicine and radiation protection is summarized. Studies in chemistry include solubility of ^{210}Po(RaF) in airborne dusts, liquid scintillation counting method for ^{14}C- and ^{3}H-labeled liquid organic acids, and a new method for sample supply in atomic absorption spectrophotometry. (P.C.H.)

39221 (ORNL-4446, pp 242-50) SPECTROMETRY RESEARCH AND DEVELOPMENT. Thorngate, J. H.; Brown, M. D.; Perdue, P. T.; Saigusa, T. (Oak Ridge National Lab., Tenn.).

Topics include energy and angular distributions of neutrons and gamma rays from the accelerator used during operation HENRE; high-purity organic scintillators; and investigations of available x-ray cross sections, with a table of x-ray absorption coefficients for carbon and oxygen for various energies from 0.277 to 40.04 keV. Also, development of a linear temperature controller for reading TSEE (thermally stimulated exoelectron emission) detectors is described. (W.H.K.)

39222 (PPAR-26) RESPONSE OF A MINERAL-OIL BASED LIQUID SCINTILLATOR TO HEAVILY IONIZING PARTICLES. Webb, R. C.; Hauser, M. G.; Mischke, R. E. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Jun 1970. Contract AT(30-1)-2137. 21p. Dep. CFSTI.

The response of a mineral-oil based liquid scintillator to heavily ionizing particles has been determined by measuring the light produced by stopping protons and deuterons. The results are expressed in terms of a saturation parameter which is found to have a value similar to that obtained in a variety of organic scintillators. (auth)

39223 (PRNC-135, pp 158-62) DATA ACQUISITION AND COMPUTER TREATMENT OF DUAL HEAD RECTILINEAR SCANNER OUTPUT. Lerner, S. R.; Cooper, P. H.; Pircher, F. J. (Veterans Administration Hospital, Houston, Tex. Baylor Univ., Houston, Tex. Coll. of Medicine).

From Radiation and isotope technology in Latin American development.

The Ohio-Nuclear Dual Head Rectilinear Scanner (5" crystals) has been made part of a data handling system for off-line data acquisition on digital magnetic tape (computer compatible). Programs have been written allowing computer manipulation of the acquired data to provide CalComp contour maps, line printer (IBM 1403) contour symbol maps and summation of data. Flexibility of programming has permitted the expansion of contouring of selected areas in order to provide greater detail where required. (auth)

39224 (STI/PUB-213) DIRECTORY OF WHOLE-BODY RADIOACTIVITY MONITORS. 1970 Edition. (International Atomic Energy Agency, Vienna (Austria)). 1970. 1035p. IAEA $25.00.

A word list of whole-body radioactivity monitors for low-level measurements is presented. A list of technical data is included in a form suitable for intercomparison of techniques applied, equipment used, and sensitivity achieved. An extensive bibliography of publications pertaining to direct measurements of body radioactivity supplements the data sheets. Also, a list of experts in the field is given. (W.H.K.)

39225 HIGH ENERGY NEUTRON FLUX DETECTION WITH DIELECTRIC PLASTICS. Frank, A. L.; Benton, E. V. (Univ. of San Francisco). Radiat. Eff.; 3: 33-7(May 1970).

Dielectric plastics were irradiated with high energy neutrons to investigate their usefulness as flux detectors. Shields thick to heavy particles and of varying composition were placed in front of the plastics to test their effectiveness as radiators. Track producing particles resulted from (n,^{4}He) reactions and from recoils

of light nuclei. Elements possessing high (n,^{4}He) cross sections were chosen as shields along with other heavy elements chosen to screen the surface of the plastic from all external track-producing particles. Carbon and aluminum satisfied the first condition while gold and lead satisfied the second. After etching, the track densities in cellulose nitrate were counted. The sensitivity under graphite varied from about 2.7×10^{-5} to 3.4×10^{-5} tracks/neutron for neutrons between 13.1 and 17.1 MeV. Useful track densities are produced by fluxes in the range of about 2×10^8 to 5×10^{10} n_0/cm^2. The $^{12}C(n,n'3^4He)$ reaction also took place in the carbon nuclei within the plastic itself. This allowed the triple-^{4}He particle tracks to be counted. The sensitivity of this method varied from about 2.7×10^{-6} to 5.7×10^{-6} tracks/neutron. The useful flux range in the best case (under gold) was from 5×10^{10} to 5×10^{11} n_0/cm^2. (auth)

39226 PRELIMINARY REPORT ON THE MONITORING OF HIGHLY IONIZING CHARGED PARTICLES ABOARD APOLLO VIII. Benton, E. V. (Univ. of San Francisco); Henke, R. P.; Richmond, R. G. Radiat. Eff.; 3: 39-42(May 1970).

Each of the nine passive dosimetry packets worn by the crew of Apollo VIII contained two 190 μ layers of Lexan polycarbonate plastic. The plastics served as threshold type, heavy charged particle track detectors. Upon recovery the detectors were first sensitized using the recently discovered photo-oxidation technique, and then etched to reveal tracks of particles whose restructed energy loss rate exceeded 2×10^3 MeV cm^2/g. A flight average of about 1 tr/cm^2 was observed. In tracing tracks through from one layer to the next it is possible to say whether a particle stops in the plastic, the sense and direction of travel, and in many cases make estimates of z to ±1 unit of charge. All the particles observed had a charge in excess of 10, 30% came to rest in the plastics. The measurements demonstrate that plastic track detectors can be conveniently and easily utilized in accurately monitoring the astronauts' high LET radiation exposure on extended space missions lasting up to several years. (auth)

39227 SENSITIVITY ENHANCEMENT OF PLASTIC NUCLEAR TRACK DETECTORS THROUGH PHOTO-OXIDATION. Henke, R. P. (Univ. of San Francisco); Benton, E. V.; Heckman, H. H. Radiat. Eff.; 3: 43-9(May 1970).

A new method is presented for the sensitization of plastic track detectors. It has been found effective for cellulosics, polycarbonates, and polyesters. Most of the reported data deals with Lexan. The method consists of irradiating plastics with ultraviolet radiation, uv, in the presence of oxygen. The sensitivity enhancement is found to increase exponentially with decreasing uv wavelength and increasing particle restricted energy loss rate, REL. This technique can be used to provide a continuously variable sensitivity from sample to sample, within a given sample, or from one etch to the next of a given sample. Greater spatial resolution is possible because of the increase in the ratio r_T/r_B. Better charge resolution is possible because of the stronger dependence of the track etch rate, r_T, on REL. Long term measurements show that samples stored in the dark in the O_2 atmosphere show a small increase in r_T with time. In inert atmospheres a negligible increase is observed, and in a vacuum r_T decreases. (auth)

39228 STATISTICALLY DESIGNED COLOR RIBBON FOR SCANNERS. Keyes, W. I.; Gillespie, P. J. (Radiotherapy Centre, Belfast). Phys. Med. Biol.; 15: 573-5(Jul 1970).

A method by which the variation in the statistical significance of color bands throughout the color display can be removed so that each color has equal significance is described. The principle of a statistical ribbon where the widths of color are made proportional to the square root of the ratemeter reading is illustrated graphically. An expression for n, where n is the nth color band and covers S standard deviations of the mean count rate, is derived and the optimum value of S considered for both statistical and linear ribbons. (UK)

39229 DETERMINATION OF FAST NEUTRON FLUX IN IRRADIATED SOLUTIONS. Bibby, D. M.; Oldham, G. (Loughborough Univ. of Tech., Eng.). Radiochem. Radioanal. Lett.; 4: 137-41(8 Jul 1970).

A method for measuring the fast neutron flux in a given volume of irradiated solution is described. The flux is determined by irradiating a solution of copper sulfate and determining the activities of the ^{62}Cu and ^{64}Cu isotopes. (auth)

39230 TECHNIQUE FOR MEASURING LIGHT OUTPUT AND DECAY TIME VS WAVELENGTH FOR SCINTILLATORS. Miller, T. G.; Polk, R. G.; Werkheiser, A. H. (Army Missile Command, Redstone Arsenal, Ala.). Nucl. Instrum. Methods; 84: 147-8 (1970).

A technique has been developed for measuring light output and decay time vs wavelength for scintillators. The technique uses a monochrometer with the scintillator placed at the entrance slit. (auth)

39231 LIVE TIME DISPLAY CLOCK. Nelson, A. V. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Nucl. Instrum. Methods; 84: 151-2(1970).

An electronic clock is described for use with a Radiation Instrument Development Laboratory (RIDL) Model 34-12 400-channel analyzer to provide a live time display. (auth)

39232 HIGH-VACUUM GAS DISCHARGE IN ELECTROSTATIC FIELDS FOR REGISTRATION OF CHARGED PARTICLES AND GAMMA QUANTA. Bobykin, B. V.; Kel'man, V. M.; Nazarenko, L. M. Zh. Tekh. Fiz.; 40: 799-804(Apr 1970). (In Russian).

It was found that gas-charged electrostatic elements with trap-like configurations of the electrodes can be used for the registration of charged particles and γ quanta at very narrow pressures in it (up to ~ 10^{-5} mm Hg). The dependence of the potential of the ignition of the discharge on the pressure and delay time of the discharge on the overvoltage on the electrodes was found experimentally. It was established that the counting speed for the γ quanta with the high-vacuum discharge elements is proportional to the intensity of the radiation. (tr-auth)

39233 LOADED LIQUID SCINTILLATORS BASED ON 1,6-DIMETHYLNAPHTHALENE AND 1-METHYLNAPHTHALENE. Koike, Y.; Yamamoto, K. (Tokyo Metropolitan Isotope Research Center). Nucl. Instrum. Methods; 84: 24-8(1970).

Pulse height properties in loaded liquid scintillators based on 1,6-dimethylnaphthalene and 1-methylnaphthalene as solvents were investigated. The half value concentration of loaded materials in pulse height of loaded liquid scintillators was determined as an index for practical purposes. Stabilities in photochemical degradation by light exposure and reduction in the pulse height by gamma-ray irradiation from ^{60}Co source were also measured. The liquid scintillators based on 1,6-dimethylnaphthalene and 1-methylnaphthalene were found to be suitable for usage as loaded liquid scintillators and many other applications. (auth)

39234 A HIGH EFFICIENCY, GADOLINIUM LOADED MINERAL OIL SCINTILLATOR FOR NEUTRON DETECTION. Clark, G. E. (Ames Lab., Iowa); Morrison, R. C.; O'Laughlin, J. W.; Burkholder, H. R. Nucl. Instrum. Methods; 84: 67-8(1970).

A mineral oil scintillator for neutron detection has been loaded with gadolinium utilizing the solubility in mineral oil of the ternary complex formed by reacting gadolinium hexanoate with tri-n-octylphosphine oxide. (auth)

39235 ION EXCHANGE COLUMN AMERICIUM MONITOR. Brown, D. P. (Pacific Northwest Lab., Richland, Wash.). Contract AT(45-1)-1830. Nucl. Instrum. Methods; 84: 74-6 (1970).

A monitor responsive to the americium content of the waste stream from a cation exchange column in which the recovery of americium takes place provides a continuous indication of column operation. Indicating waste line concentrations from 5×10^{-7} to 6×10^{-4} g/liter, the monitor allows determination of the proper time to elute the product from the column and indicates undesired process conditions. (auth)

39236 USE OF GADOLINIUM AND SAMARIUM FILTERED NON-1/v-LAW INDICATORS. Schumann, P. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 13: 116-21 (Apr 1970). (In German).

Using gadolinium and samarium filters, the activation cross-sections of non-1/v-law indicators may be changed in such a manner that quite original cross-section curves will be simulated. For gray filters ($\Sigma_{ab_1}(E_n)d_F \approx 1$), measurement and calculations cannot agree with each other but in that case where the geometric array is taken into account and energy-dependent flux depression is neglected. Optimum matching between measurement and calculation can be obtained if the parameters of the calibration spectrum used are changed in a physically suggestive manner. Gd-filtered indicators show marked sensitivity to neutron temperature. (auth)

39237 A SINGLE-CHANNEL PULSE-HEIGHT ANALYSER WITH 100 NANOSECONDS RESOLUTION. Cole, H. A. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 84: 93-101(1970).

A single-channel pulse-height analyser is described having a dynamic range of threshold and channel width of 200:1, and a signal resolution of 100 nsec. Channel position and width may be adjusted independently by internal or external means (external means by potentiometer or analogue voltage), the width being adjusted symmetrically or asymmetrically as desired. Temperature stability of channel position and width is better than ±0.005%/

°C over the operating range −25 mV to −5 V. Paralysis may be preset over the range 0.1 to 50 μsec and an external strobe facility is provided to reduce time-walk. The instrument may also be operated as two independent discriminators (with internal control) sharing a common input terminal. (auth)

39238 PULSE SHAPE DISCRIMINATION WITH ORGANIC LIQUID SCINTILLATOR SOLUTIONS. Horrocks, Donald L. (Argonne National Lab., Ill.). Appl. Spectrosc.; 24: 397-404 (Jul-Aug 1970).

The source of the delayed fluorescence by triplet−triplet interactions is discussed as the basis of the technique of differentiating between particles of different specific ionizations. The variation in the relative intensity of delayed fluorescence (called the slow component of scintillation) is correlated with the type of ionizing radiation. The decay times of the prompt and slow components do not depend upon the type of ionizing particle. The slow component in liquid scintillator solutions free of dissolved gases (especially oxygen) has a decay time of about 250×10^{-9} sec. Liquid scintillator solutions with pulse shape discrimination properties have been used to measure neutrons (proton recoils) in the presence of gamma rays (Compton scattered electrons). They have also demonstrated ability to measure the relative activities of alpha particles and fission fragments from a fission source in the presence of gamma and beta background. (25 references) (auth)

39239 INFRARED EVALUATION TECHNIQUES FOR Ge(Li) DETECTORS. Armantrout, G. A. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 16-23(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The types of Ge(Li) detector spectrum degradation due to "trapping effects" are first considered, and a model is presented which explains this degradation in terms of specific phenomena. Then two detector evaluation techniques which utilize infrared light for studying these phenomena are outlined and the significant results obtained using these techniques are presented. The infrared absorption measurement yields information concerning apparent strain in the crystal which can be related to localized trapping effects in the detector. The detector response to monochromatic infrared light determines the presence of localized lithium precipitation (a major cause of spectrum tailing) and permits a quantitative measurement of the important carrier traps in germanium such as the lithium-defect trap, copper, nickel, and iron. Utilizing these measurements, it is possible to completely characterize the performance of a crystal and determine the source of detector degradation in one day. Very good correlation is consistently obtained. (auth)

39240 CHARACTERISTICS AND WINDOW THICKNESSES OF ION IMPLANTED SEMICONDUCTOR DETECTORS. Sebillotte, Ph.; Siffert, P.; Coche, A. (Centre de Recherches Nucleaires, Strasbourg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 24-32(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A study of the main characteristics of boron ion implanted N-type silicon detectors is presented: a FWHM of 3.1 keV has been obtained at 77°K for 1 MeV conversion electrons. Special emphasis is given to the window thickness of these counters, which is deduced from the pulse height defect observed for low energy protons as compared to γ-rays of the same energy. The variation of the window thickness with the applied bias voltage is studied for different values of the following parameters: starting material resistivity, crystal axis orientation, dose, annealing temperature. These measurements allowed the determination of the implanted impurity distribution profile down to eight or nine orders of magnitude below the maximum of this profile. (auth)

39241 VARIATION OF THE EFFECTIVE FANO FACTOR IN A Ge(Li) DETECTOR. Sher, A. H.; Keery, W. J. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 39-43(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Variations in the value of the effective Fano factor, F', have been observed in Ge(Li) detectors using a collimated beam of γ-rays to irradiate selected areas in the sensitive region between the n^+- and p-contacts. For regions near the n^+-contact where the trapping of electrons is minimized, F' was found to be statistically less than 0.11. (auth)

39242 CHARACTERISTICS OF A FUNNEL TYPE ELECTRON CHANNEL MULTIPLIER WITH A GRID ENTRANCE WINDOW. Ray, J. A.; Barnett, C. F. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 44-8(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The response uniformity across the entrance window of a 1 cm diam funnel electron channel multiplier has been increased by installing a high transparency grid in front of the multiplier and operating at the same potential. The funnel surface was scanned by a 1/8 diam 1 to 20 keV hydrogen atom beam. With either a negative potential applied to the front edge or positive potential to the collector, the response as indicated by the counting rate was flat over the central 8 to 9 mm multiplier aperture. Measurements of the multiplier gain indicated maximum gain near the outer edge and minimum gain in the channel region. (auth)

39243 X-RAY IMAGE INTENSIFIER TUBES USING RARE EARTH OXYSULFIDE PHOSPHORS. Wang, S. P. (Zenith Radio Corp., Niles, Ill.); Laudi, O.; Lucks, H.; Wickersheim, K. A.; Buchanan, R. A. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 49-56(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Improved utilization of incident x-ray quanta in medical x-ray image intensifier tubes will allow operation at reduced x-ray dose levels and/or yield pictures with higher signal-to-noise ratio. This paper describes the characteristics and performances of experimental screens and image intensifier tubes using La_2O_2S(Tb) and Gd_2O_2S(Tb) phosphors. Improved quantum utilization by a factor of 2 to 3 is observed relative to screens and image intensifier tubes made with conventional ZnCdS(Ag) phosphors. Accordingly, reduction of patient and operator dosage by a factor of 2 to 3 is found to be possible. (auth)

39244 RARE EARTH OXYSULFIDE X-RAY PHOSPHORS. Wickersheim, K. A.; Alves, R. V.; Buchanan, R. A. (Lockheed Palo Alto Research Lab., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 57-60(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Two rare earth materials, La_2O_2S: Tb and Gd_2O_2S: Tb, have significant potential as input-screen phosphors for x-ray image intensifier use. These materials exhibit high luminescent efficiencies and high x-ray absorption. In this paper we present a detailed discussion of the properties of these new phosphors and suggestions for further improving their performance in image intensifier tubes. (auth)

39245 DOUBLE-DRIFT THIN-WINDOW PLANAR Ge(Li) DETECTORS. Okubo, Dan (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 61-4(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

An improved method for fabricating a thin-window planar detector was developed at Lawrence Radiation Laboratory, Livermore. This detector is designed to analyze spectra of low-energy as well as high-energy gamma and x rays. The detector has a planar configuration with a relatively large gold surface barrier entry window. The main advantage of this detector is its faster drifting time coupled with minimum waste of material. This method of fabrication has significant advantages over earlier techniques. (auth)

39246 APPLICATIONS OF CADMIUM TELLURIDE NUCLEAR RADIATION DETECTORS. Beavin, Rudy C.; Snowball, Harry M. (Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 65(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Aerospace applications of nucleonic techniques require a "Practical" detector offering detection efficiency, some energy discrimination capability, and most importantly, storage and operation over a wide temperature range, e.g., −125°C to +150°C. It is stated that current CdTe detectors offer the best available achievement of these goals with a high probability of future extension. (auth)

39247 RADIAL RESISTIVITY PROFILE IN HIGH-PURITY SILICON. Alberigi Quaranta, A.; Canali, C.; Ottaviani, G.; Taroni, A.; Zanarini, G. (Univ., Modena, Italy). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 66-71 (Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The radial profile of ionized impurities concentration was determined in different high purity silicon wafers, used for manufacturing solid state detectors. The measurement was carried on by determining as a function of radial position the depletion voltages of surface barrier dE/dx detectors made on

the samples under study and whose circular useful surfaces were concentric with the wafers. The ratio between the diameter of the detectors useful surfaces and the diameter of the wafers was between 0.75 and 0.85. The point-by-point depletion voltages were measured by means of ionizing particles sent on the back side of the detectors. All the samples considered showed a maximum of ionized impurities concentration at the center of the slice and the variation between the center and the edges was of the order of 60% with respect to the maximum value. These radial non-uniformities can remarkably change the performance of detectors with respect to the uniform concentration case. Particularly in nuclear spectrometry, if possible radial variations in the depletion region depth are not taken into account, worse resolving powers and pulse height defects can result. (auth)

39248 LONG-TERM STABILITY CHARACTERISTICS OF COMMONLY USED CHANNEL ELECTRON MULTIPLIERS. Klettke, B. D.; Krym, N. D.; Wolber, W. G. (Bendix Research Labs., Southfield, Mich.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 72-80(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The gains of seven units of a commonly used channel electron multiplier model have been observed as a function of total accumulated counts in a clean, ion-pumped vacuum station at 3×10^{-10} torr. After decreasing by a factor of two to three during the first 5×10^{7} counts of operation, all gains remained relatively constant until the channel multipliers had each accumulated about 10^{10} counts at which time a continual degradation began. A typical channel electron multiplier degraded from a gain of 1.25×10^{8} at 10^{10} counts to 7.0×10^{7} at 1.4×10^{11} total accumulated counts. The effects of gain fatigue on high count-rate capability, on resistance, and on the output pulse-height spectrum shape are also presented. Less extensive data showing the long-term stability characteristics of a newer model of channel multiplier with longer life are included. (auth)

39249 APPROXIMATE METHODS FOR CALCULATION OF INTRINSIC TOTAL-ABSORPTION- AND DOUBLE-ESCAPE-PEAK EFFICIENCIES FOR Ge(Li) DETECTORS. Euler, B. A.; Kaplan, S. N. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 81-90(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Approximate methods are presented for calculation of intrinsic total-absorption- and double-escape-peak efficiencies of Ge(Li) detectors. These methods utilize average characteristics of gamma-ray photon interactions with matter, and, while developed in this paper for specific application to the Ge(Li) detector efficiency problem, should be applicable to any gamma-ray detector or absorptive medium. The technique for total-absorption-peak efficiency determination includes the use of an "average-photon energy-degradation curve" and of the Dirac chord method for calculation of collision probabilities. The average-photon energy-degradation curve is obtained from differential Compton collision cross sections and detector material total-cross-section characteristics; it is dependent of detector size and shape. The Dirac chord method is then used to determine the probability of further collisions for photons "generated" within the detector volume. In the model these probabilities are functions only of a characteristic detector dimension, $\bar{s}\mu$, where $\bar{s}$ is the average chord length and μ is the total linear attenuation coefficient. Double-escape-peak efficiencies are determined through the calculation of the average probability of occurrence of the following three phenomena: (1) pair production, (2) electron-positron absorption, and (3) annihilation-photon double escape. Complete working curves and expressions are included to enable convenient utilization of these techniques. Example results are compared with efficiency determinations made experimentally and by Monte Carlo calculations. (auth)

39250 LARGE AREA BERYLLIUM PROPORTIONAL COUNTERS. Tananbaum, H.; Kelloggi, E. M. (American Science and Engineering, Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 97-101 (Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Proportional counters have been developed for use in satellite x-ray astronomy experiments. The counters are all beryllium with 2.5 mil (63.5 micron) windows, using epoxy seals. They are shown to have excellent long-term stability and resistance to environmental stress, except for 100% humidity. (auth)

39251 IN-FLIGHT CALIBRATION SYSTEMS FOR PARTICLE DETECTOR EXPERIMENTS. Peletier, Daniel P. (Johns Hopkins Univ., Silver Spring, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 110-16(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

This paper briefly reviews some in-flight calibration systems used on satellite particle detector experiments and gives a detailed description of the technique used to calibrate the IMP-I Solar Proton Monitoring Experiment (SPME). A short discussion of each calibration technique is presented in an attempt to inform the reader of the potential uses of in-flight calibration systems. The SPME in-flight calibrator illustrates the trade-offs made in the design of a calibrator for an experiment which uses silicon solid state detectors. A meaningful measure of detector performance is obtained by use of a noise monitor which measures the effective average noise of the detectors with ±2% accuracy over a 10:1 dynamic range and a 5 MHz bandwidth. In addition, the SPME incorporates a pulser which makes a ±2% check of amplifier gains and discriminator level settings by applying a piecewise linear envelope of charge pulses to the charge sensitive preamplifiers. (auth)

39252 HYBRID COCKROFT WALTON MULTI-DYNODE PHOTOMULTIPLIER SUPPLY FOR SPACE APPLICATIONS. Shute, Donald W. (Space and Tactical Systems Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 130-7(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A system for generating and controlling high voltage D.C. potentials for use with photomultiplier tubes is described. Emphasis is placed on simplicity of electrical and mechanical design through the use of modern miniature components and thick film technology. The photomultiplier power converter was designed to supply the potentials required by the P.M. tube in a particle spectrometer for high counting rates. The high voltage is programmable over a limited range (100V) for automatic experiment calibration adjustment. The prime parameters to be considered in the design were: voltage stability, high load current capability, low ripple, programmable, multi outputs for the dynodes, low power consumption, small size and weight, and direct package interface with a round P.M. tube housing. (auth)

39253 INSTRUMENTATION FOR IN VIVO NEUTRON ACTIVATION ANALYSIS IN HUMANS. Palmer, H. E. (Battelle Memorial Inst., Richland, Wash.); Pailthorp, K. G.; Sheen, E. M.; Nelp, W. B.; Murano, R. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 138-43(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The application and methods of in vivo neutron activation analysis to measure the chemical composition of the major elements in the human body are still in the early stages of development. However, the technique is being used routinely to measure total body calcium which cannot be accurately measured by any other method at the present time. The instrumentation required for determining the total body content of major elements in humans after exposure to a low level neutron flux includes an automated system to provide a safe, precise, and uniform neutron irradiation throughout the entire body and a sensitive whole body counting system for measuring the gamma rays from the radionuclides produced in the body. (auth)

39254 NUCLEAR RADIATION DETECTION FOR THE NATURAL ENVIRONMENT. Kastner, J.; Oltman, B. G.; Feige, Y.; Gold, R.; Congel, F. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 144-50(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Liquid scintillators, proportional counters, nuclear emulsions, etched track detectors, and thermoluminescent crystals have been used to measure the environmental neutron flux from thermal to 10 MeV energies below ground, at ground level, at an air-water interface, on a tower, and at an airborne altitude of 20,000 feet. Results are compared with calculations based on a modified program for reactor computations. (auth)

39255 SYSTEM FOR THE MEASUREMENT OF DEPOSITION AND RESUSPENSION OF RADIOACTIVE PARTICULATE RELEASED FROM PLOWSHARE CRATERING EVENTS. Holladay, Gale; Bishop, Stanley R.; Phelps, Paul L.; Anspaugh, Lynn R. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 151-8(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Potential benefits to man from the use of nuclear explosives for excavation are considerable. Proposed applications actively

being studied under the Atomic Energy Commission's Plowshare Program include construction of canals, harbors, and dams. Potential economic advantages of nuclear explosives over conventional chemical explosives and excavation machinery are so great as to permit consideration of projects otherwise entirely unfeasible. However, the use of nuclear explosives in excavation projects implies the potential release of radioactivity into the biosphere. The biological implications of such releases must be evaluated before any nuclear excavation project can be seriously considered. The Bio-Medical Division of the Lawrence Radiation Laboratory of Livermore is pursuing investigations intended to systematically analyze the effects on the biosphere of the release of radionuclides from experimental Plowshare cratering events. Data from these studies will be used to evaluate and refine existing predictive methods. (auth)

39256 RAPID EVALUATION OF ENVIRONMENTAL RADIATION SIGNATURES UTILIZING AN AIRBORNE PLATFORM. Anderson, C. N.; Eskridge, H. E. (EG and G, Inc., Las Vegas, Nev.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 159-64(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The AEC and the nuclear industry have historically been committed to environmental control of nuclear effluents. A valuable tool in this control is a sophisticated aerial radiation detection and tracking system operated for the AEC by EG&G, Las Vegas, Nevada. The components and applications of this aircraft-carried air sampling system are described, and typical missions are illustrated. (auth)

39257 AN ANALYSIS OF DIGITALLY PROCESSED COLOR READOUTS FROM SCINTILLATION CAMERAS AND SCANNERS. Goldman, Samuel C.; Wheaton, Brian A.; Albrecht, Lance M. (Picker Corp., North Haven, Conn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 165-72(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017(Pt.1).

The application of nuclear engineering discussed in this paper relates to digital processing of images formed by the detection of gamma radiation retained in various organs in the body after the injection of radio-pharmaceuticals. These images are presented in a color photograph display to aid diagnosis and minimize system artifacts. (auth)

39258 RECENT RESULTS ON THE OPTOELECTRONIC FEEDBACK PREAMPLIFIER. Goulding, F. S.; Walton, J. T.; Pehl, R. H. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 218-25(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A brief description of the optoelectronic feedback system is followed by an account of some interesting aspects of low-noise preamplifiers and detectors revealed by this work. These include the following items: (1) The observation of hole collection at the gate of a FET analogous to ion collection at the grid of a vacuum tube. (2) Mechanical failure modes of light-emitting diodes when cycling their temperature to and from 77°K. (3) A counting-rate effect due to the mean current in the feedback path. This naturally leads to a philosophical discussion of the equivalence of resistor and light-coupled feedback systems. It also suggests the potential advantages of using a pulsed, rather than dc, feedback system. Also, the use of the optoelectronic feedback system for the observation of a Fano factor of .08 or less for a germanium detector is reported. (auth)

39259 LOW NOISE PREAMPLIFIER FOR SIMULTANEOUS HIGH RESOLUTION ENERGY AND TIME MEASUREMENT WITH SEMICONDUCTOR DETECTORS. Sherman, I. S.; Roddick, R. G. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 252-9(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A new charge sensitive preamplifier permits state of the art timing with semiconductor detectors without compromising energy resolution. The compromises that are involved in previous methods of obtaining amplitude and time information are avoided by using a single input FET followed by fast, low noise circuitry. With the same input transistor the noise in the "energy" channel is the same to within a few per cent as for the best room temperature preamplifiers. There are two timing outputs. The faster of these is voltage sensitive and has a rise time of 2 nsec. The slower output, which is obtained from the output of the charge sensitive loop, has a rise time of less than 5 nsec for external input capacities up to 50 pF with 0.5 pF feedback capacitor. The leading edge response can be adjusted to approach an exponential function with a time constant as low as 6 nsec. This property is desirable when timing with thick detectors that have a fluctuating charge collection time, where it is necessary to trigger near the base line. (auth)

39260 METHODS OF REDUCING NOISE OF JUNCTION FIELD EFFECT TRANSISTOR (JFET) AMPLIFIERS. Kern, H. E.; McKenzie, J. M. (Bell Telephone Labs., Inc., Murray Hill and Whippany, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 260-8(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

At present in non-dispersive x-ray spectrometers the electronic noise of the pulse amplifier input circuit prevents full realization of the inherent resolution of the semiconductor detector. Commercially available low noise JFET's encapsulated with boro-silicate (7052) glass insulated headers have typical noise contributions to detector resolution widths (FWHM), at 25°C, of 326 eV (Si). JFET's encapsulated with BeO or Al_2O_3 headers contribute ~200 eV to the resolution at 25°C and 150 eV at about -20°C. Techniques to select passive components which do not inhibit the performance of these transistors are discussed. (auth)

39261 DISCRIMINATOR-STABILIZER WITH INTERNAL COMPENSATION FOR EXTERNAL GAIN SHIFTS. Lenkszus, F. R.; Rudnick, S. J. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 285-90 (Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A counting system stabilizer, which provides two gain-stabilized data channels without requiring an external gain-controllable element, is described. Measurements show that in a typical NaI photomultiplier system subjected to normal environmental perturbations, net gain fluctuations were reduced to about 0.05%. (auth)

39262 COMPARISON OF CONSTANT FRACTION AND LEADING EDGE TIMING WITH NaI(Tl) SCINTILLATORS. Nutt, R.; Gedcke, D. A.; Williams, C. W. (ORTEC, Inc., Oak Ridge, Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 299-306(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The technique of constant fraction of pulse height is shown to be useful for timing with NaI(Tl) scintillators. A comparison of the results of constant fraction timing with leading edge timing indicates that the two techniques are equivalent for small dynamic ranges. For large dynamic ranges constant fraction timing is shown to be a significant improvement over leading edge timing. Also, constant fraction timing over narrow dynamic ranges represents an improvement of 13.7 over the slow crossover timing with NaI(Tl). Multiple time sampling is used to investigate how much time information is contained in a NaI(Tl) scintillator pulse. Since an additional time sample represents an improvement of only 11 percent over a single constant fraction measurement, it is concluded that a system more sophisticated than constant fraction will not significantly improve the time resolution. (auth)

39263 LINEAR, WIDEBAND, LOW-NOISE AMPLIFIER STAGE FOR USE IN NUCLEAR PULSE AMPLIFIERS. Millard, J. K.; Blalock, T. V. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 307-25 (Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The design evolution of a wideband voltage-sensitive amplifier stage is presented. For the basic stage, including a new driver configuration and overload control circuit, three basic input sections are considered; the first section consists of differentially connected bipolar transistors for use with low generator impedances, the second consists of medium-transconductance FETs to allow larger coupling time constants, and the third consists of high-transconductance FETs for low-noise performance with large coupling time constants. Large- and small-signal bandwidth analysis is given for each configuration. From this analysis, criteria are established for allowing equal large- and small-signal rise times. Also, for each type of input section, expressions of equivalent noise voltage are derived. A table of experimental results is presented, summarizing data obtained for several important performance parameters. Typical measurements for the medium-transconductance FET input section for a voltage gain of 16 include small- and large-signal rise times of 10 nsec, overload recovery times from a 5-v input of ~20 nsec, and integral nonlinearity of < 0.05%. (auth)

39264 LOW-CURRENT MEASUREMENTS USING TRANSISTOR LOGARITHMIC DC ELECTROMETERS. Kennedy, E. J. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 326-34(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A nine-decade (10^{-13} to 10^{-4} amp) and a five-decade (4×10^{-12} to 4×10^{-7} amp) dc logarithmic electrometer have been designed, and their performance evaluated. The problems of drift, linear-to-log conversion accuracy, temperature dependence, and frequency response are considered. An accuracy of better than ±0.6%/decade (~2% of reading) was achieved. (auth)

39265 GLASS MEMORY PULSE HEIGHT ANALYZER FOR EDUCATIONAL APPLICATIONS. Waugh, J. B. S. (Univ. of Rochester, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 345-53(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

An inexpensive, compact, low-power glass delay line memory PHA, functionally designed for educational, as distinct from research applications, is described. Using series 74 I/C logic and consuming 20W with CRT display, it performs the basic sorting function, can be strobed, and contains a three-stage digital buffer derandomizer giving it virtually zero resolving time up to 8 kp/s input. The novel logic schemes are described. (auth)

39266 HIGH TEMPERATURE AND GAMMA EFFECTS ON COUNTING-TYPE NEUTRON FLUX DETECTORS. Jackson, C. N. Jr.; Hoitink, N. C. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 369-75(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Neutron flux detectors of the counting type, as designed for thermal reactors may provide a capability for some fast reactor control safety and surveillance applications. Short-term tests in environments of up to 10^6 R/hr gamma and to 950°F served to characterize the operational limits for uranium-235 fission chambers and boron-10-lined proportional counters. Fast pulse-shaping techniques (20 to 50 nanoseconds) improved the gamma tolerance capability of sensors having collection times of 50 to 200 nanoseconds. (auth)

39267 A FAST BUFFER MEMORY FOR PARTICLE PHYSICS. Keller, Karl B. (EG and G, Inc., Salem, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 416-18(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Difficulties exist in recording patterns from large multiple detector arrays in experiments at accelerators having (a) short (microsecond) beam pulses producing multiple events, (b) longer beam spill producing many events, or (c) high intensity, with fast event pairs or triplets. A fast buffer memory may be used to acquire many events (detector array patterns) asynchronously in real time before transferring them synchronously to the relatively slower computer core memory. The technique described uses write-only multiword storage, followed by read-only block transfer to the computer. This permits, at the input, minimal logical testing for ready status after writing each pattern, for high acquisition rate capability. Similarly, the transfer of a significantly large block of data maximizes the potential of the computer's I/O channel by reducing the per-word "over-head" — interrupt recognition, channel setup time, etc. (W.H.K.)

39268 IN-CORE MICROWAVE THERMAL NEUTRON SENSORS. Brown, D. P.; Billeter, T. R.; Spear, W. G. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 486-94(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

This paper presents the results of in-core experiments conducted to demonstrate the performance of microwave neutron flux detectors. For a microwave resonant cavity, a frequency shift, as caused by a neutron-generated plasma within the cavity, results in a detection technique capable of covering up to six decades of reactor power. (auth)

39269 ANALYSIS OF THE DIFFERENCES BETWEEN TRUE-MEAN-SQUARE AND AVERAGE-MAGNITUDE-SQUARED DETECTOR CIRCUITS FOR USE IN CAMPBELLING NEUTRON MONITORING SYSTEMS. Hsu, Chun; Popper, Glenn F. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 506-9(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A mathematical analysis and some numerical results are presented that indicate how the ratio of the outputs from a true-mean-square and an average-magnitude-squared linear type detector in a Campbelling neutron monitoring system varies over a wide range of neutron fluxes or pulse rates for a given system output signal shape. Two types of system output pulse shapes have been considered. One type is of the form $v = Ve^{-\omega t}$ corresponding to a single differentiated output pulse. The other shape has the form $v = C_1\epsilon - \omega t + C_2\epsilon - \omega_1 t + C_3\epsilon - \omega_2 t$ corresponding to a double differentiated and single integrated output pulse. C_1, C_2, and C_3 are constants depending upon the system characteristics. For the single differentiated pulse shape, the analysis verifies that the output signal ratio begins to deviate from the constant value 0.637 when the input pulse rate decreases below the single low cut-off frequency, ω, of the system. As for the double differentiated, single integrated pulse shape, all three time constants influence the results. For the specific case where the integrating time constant, $1/\omega_2$, is much smaller than either differentiating time constant, $1/\omega$ or $1/\omega_1$, and these last two time constants are made equal, the output signal ratio also deviates from the constant value of 0.637 when the input pulse rate decreases below the low cut-off frequencies. Some measurements of the two types of output signals, $|\bar{v}|^2$ and $\bar{v}^2$, obtained from actual Campbelling systems, show excellent agreement with the numerical results for both types of pulse shape considered. (auth)

39270 SILICON RADIATION DETECTOR MONITORS NITROGEN 16 IN A POWER REACTOR. Mallory, P. G. (Canadian General Electric Co. Ltd., Ontario). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 520-3 (Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A totally depleted diffused junction silicon radiation detector is used to monitor ^{16}N in the coolant of a heavy water nuclear power reactor. The detector operates at boiler room ambient temperature and is stable and reliable. The system provides discrimination against background from corrosion and activation products with very little shielding required. The detector characteristics which affect accuracy are described and special features are incorporated to improve system stability. (auth)

39271 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR ISOTOPE DIAGNOSIS. (to Siemens Aktiengesellschaft). British Patent 1,195,009. 17 Jun 1970. Priority date 1 Jun 1968, Germany.

An apparatus is described for isotope diagnosis to determine the distribution of radioactive substances in a body by simultaneous synchronous scanning of an examination zone using two radiation detectors directed onto the zone from different directions. (C.E.S.)

39272 DEVICE FOR DETECTING THE PRESENCE OF FISSION PRODUCTS IN THE COOLANT LIQUID OF A NUCLEAR REACTOR. Strindehag, Ove Magnus (to Aktiebolaget Atomenergi). British Patent 1,187,987. 15 Apr 1970. Priority date 16 Jun 1966, Sweden.

A Cherenkov detector for detecting the presence of fission products in the coolant liquid of a nuclear reactor, comprising a measuring chamber having an inlet and outlet for the coolant, is described. The walls of the measuring chamber are provided with a layer of optically transparent material. A photomultiplier is connected to the measuring chamber for measuring Cherenkov radiation generated by the fission products which emit beta radiation of more than 4 MeV. (C.E.S.)

39273 MULTIPLE DETECTOR RADIATION SCANNING DEVICE. Hindel, Robert; Utting, George R. (to Picker Corp.). U. S. Patent 3,509,341. 28 Apr 1970. Filed 1 Jun 1966.

A multichannel scanner is disclosed for mapping radioisotope distribution within a human body. The device employs a movable arm housing a scanning head enclosing a linear array of relatively large scintillation crystals. Each crystal is mounted on a collimator unit focused to an external point and atop each crystal is a light pipe and photodetector. The head is controlled to cause the focal points to trace an interlaced pattern. Digital to analog circuitry provides a cathode ray tube display as one output, the spatial position of each collimator unit being converted to vertical and horizontal deflection voltages and the incidence of scintillations being converted to spot intensity. There is also provided a single control means for simultaneously adjusting the central energy and window width of all channels. (auth)

39274 IMAGING DEVICE FOR RADIOACTIVITY DISTRIBUTION. Woronowicz, Eric M. (to Nuclear Chicago Corp.). U. S. Patent 3,502,873. 24 Mar 1970. Filed 15 Jun 1967.

A positron camera with a simplified control circuit for selecting the depth in a subject at which the radioactivity distribution is most sharply imaged is described. (auth)

39275 APPARATUS FOR MEASURING STRENGTHS OF RADIOACTIVE SOURCES. Bradley, John Ernest Stobart

(to National Research Development Corp.). British Patent 1,186,928. 8 Apr 1970. Filed 7 Dec 1967.

Reference is made to means of overcoming background effects when measuring the strengths of radioactive sources. Apparatus in which provision is made for this complication may comprise two similar detector systems both responsive to background effects but only one of which is arrayed to be responsive to the source under investigation, together with a comparison means having two inputs from the detector system to give an indication of the differential between the two inputs. Any mismatch between the detector systems will give rise to errors in measurement, since the indication given will contain a contribution due to the background, and these errors may be large if the background level is high in relation to the strength of the source under investigation. An arrangement is described whereby tolerance to mismatch between the two detector systems alternately responsive to radiation from a source under investigation and for synchronously interchanging the connections between the outputs of the detector systems and the inputs of the comparison means. (U.K.)

39276 IMPROVEMENTS IN OR RELATING TO QUATERNARY AMMONIUM COMPOUNDS AND THEIR USES. (to Nuclear-Chicago Corp.). British Patent 1,192,401. 20 May 1970. Priority date 11 Apr 1966, United States.

A solvent composition for dissolving radioactive samples for liquid scintillation counting, the composition of which comprises at least one quaternary ammonium compound, is described. (C.E.S.)

39277 VITREOUS COMPOSITION FOR MEASURING NEUTRON FLUX. Yokota, Ryosuke; Muto, Yuhei; Nakajima, Saburo; Fukuda, Kiyoshi (to Tokyo Shibaura Electric Co., Ltd.). British Patent 1,194,141. 10 Jun 1970. Priority date 17 Jan 1967, Japan.

A vitreous composition that essentially consists of an alkali metal metaphosphate throughout which there is uniformly distributed a fissile material in the form of an oxide is presented. The vitreous composition is particularly sensitive to fast neutrons. (C.E.S.)

39278 SYSTEM FOR HANDLING NUMERICAL DATA FROM SCINTIGRAPHIC IMAGES. Playe, F. (Intertechnique, Plaisir, France). Onde Elec.; 50: 475-82(May 1970). (In French).

After a brief recapitulation of existing techniques employed in scintigraphy, the numerical handling of the information obtained from the detectors is discussed. The set up described is an assembly of modules, which accept raw data from a scintillation camera or a scanner and converts it into a numerical form. This information is subsequently recorded, either by a memory core (static studies) or on magnetic tape (dynamic studies) which may be examined later. The system also includes a computer for handling the data concerning the scintigraphic images (normalization, smoothing etc.). (auth) (France)

39279 1970 TWELFTH SCINTILLATION AND SEMICONDUCTOR COUNTER SYMPOSIUM, WASHINGTON, D. C., MARCH 11-13, 1970. Chase, Robert L. (ed.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 1-494(Jun 1970). (CONF-700301).

Separate abstracts were prepared for the 60 papers presented. (W.H.K.)

For abstracts of individual papers see: 39280-39316, 39338-39348, 39361-39368, 39407-39409, and 40484.

39280 MODIFICATION OF THE CHARPAK CHAMBER WITH FOIL SUPPORTED CONDUCTORS. Neumann, M. J.; Nunamaker, T. A. (Univ. of Chicago). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 43-9(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

A conductive film supports the anode wires of a multi-wire proportional type counter and a bias voltage applied through this film controls the electric field concentration around the anode wires. Because the critical operating voltage is applied through the film one has increased freedom in the mechanical design of these chambers. Two coordinates of spacial information are available with this technique. The first coordinate is the anode wire signals. The second is obtained by a grid of ribbons on the back of the anode supporting film which picks up an induced signal from the primary discharge. Spacial resolution of 1.6 mm fwhm has been measured using the induced readout ribbon grid along with 3.3 mm fwhm on the anode grid. We expect this to improve. (auth)

39281 MULTI-WIRE PROPORTIONAL COUNTERS FOR LOW-ENERGY PARTICLES. Braid, T. H.; Campbell, G. G.; Rush, C. J.; Caya, G. E.; Becker, J. R.; Himes, J. L.; Leib, R. J. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 60-4(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

We have constructed multi-wire proportional-counter arrays in which only every second wire operates as an anode, the others being held at the cathode potential, and have investigated their response to α particles. The variation of the sensitivity and amplification with voltage and with different geometrical arrangements is described. (auth)

39282 RECENT DEVELOPMENTS IN GaP(Cs)-DYNODE PHOTOMULTIPLIERS. Krall, H. R.; Helvy, F. A.; Persyk, D. E. (RCA Electronic Components, Lancaster, Pa.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 71-4 (Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Recent developments in GaP(Cs)-dynode photomultipliers are reviewed. The physics of secondary emission is discussed and models are described which explain secondary emission from conventional dynode materials and from GaP(Cs) dynodes. The concept of negative electron affinity is explained in terms of an energy diagram. Device performance is reported with regard to both electron and time resolution. A general discussion of the characteristics of GaP(Cs)-dynode photomultipliers is included. (auth)

39283 PM OF NEW DESIGN FOR HIGH SPEED PHYSICS. Chevalier, Ph.; Boutot, J. P.; Pietri, G. (Laboratoires d'Electronique et de Physique Appliquee, Limeil, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 75-8(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Total transit time of the order of 1 ns with a standard deviation of less than 0.1 ns and an impulse response better than 0.3 ns FWHM are typical characteristics of a new type of PM designed and developed at LEP. These performances are obtained with the following applied voltages: between photocathode and multiplier entrance: 1 kV; across the multiplier: 1 kV to 1.5 kV; between multiplier output and collector: 2 kV. The overall dimensions of the tube are: maximum diameter 40 mm, length 80 mm. It is explained how these performances are achieved, due to a new design, compared to the classical approach. The predicted data, deduced from a computer program (dealing with electron multiplication in channels) are compared to the experimental figures obtained from a coincidence study through a short pulse source, a time to amplitude converter, and a multichannel analyzer. Some typical applications are described such as high energy physics and quantum electronics. (auth)

39284 NEW DEVELOPMENTS ON PHOTOMULTIPLIER TUBES AT RTC (LA RADIOTECHNIQUE: COMPELEC. Nussli, J. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 79-81(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Continuing interest at RTC, in the field of scintillation counting, has led to the development of a photomultiplier (PM) for liquid scintillation equipments, the XP1230. Special attention has been brought to the problems of high detection efficiency, and low coincidence background. Also activity in the field of PM for space applications has been continued. The family of rugged tubes has been extended: Tubes for photometric and fast scintillation counting have been developed. (auth)

39285 SCINTILLATION MECHANISM IN THALLIUM DOPED ALKALI HALIDES. Kaufman, R. Gilbert; Hadley, Wayne B.; Hersh, Herbert N. (Zenith Radio Corp., Chicago). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 82-8(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

The scintillation mechanism for alkali iodides doped with thallous iodide was studied. Conclusions are listed. (1) Most of the luminescence, and possibly all of it, is from recombination and therefore energy transfer is predominantly from charge transport to thallium. (2) There are two modes of recombination at thallium which differ in the sequence of charge trapping at Tl^+. The electron may be trapped before a mobile hole recombines with it, or the hole may be trapped before recombination with a free electron. (3) Thermal hole diffusion is an important process at room temperature and determines which mode a recombination event follows. (4) Both modes of recombination are active. (5) There is non-thermal hole trapping which is a significant part of the scintillator mechanism. (auth)

39286 HIGH Z SCINTILLATOR. Rosette, K. H. (Harshaw Chemical Co., Solon, Ohio); Farukhi, M. R.; Kramer, Gerald R.; Swinehart, Carl; Hofstadter, R. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 89-94(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Thallium chloride, activated with iodides, has been found to scintillate. Photopeaks for the ^{137}Cs .662 MeV gamma energy have been obtained with several crystals, while many other TlCl crystals, prepared with different iodides of varying low concentration show smaller scintillation response. Pulse height varies with the activators used. The consistently largest output to date is measured for TlCl (Be,I). A maximum pulse height of 2.5% relative to NaI (Tl) has been measured. The best resolution value is 42% at .662 MeV for ^{137}Cs. The gamma ray excited luminescence agrees remarkably well with the low temperature intrinsic luminescence of TlCl at 4650 Å. A scintillation decay time of 0.2 microseconds is obtained. Having good mechanical and thermal shock resistance, high density and the highest atomic number of any scintillator known to date, iodide activated TlCl promises to be an important new scintillator. The scintillation efficiency and decay time are sufficient for consideration in high energy counters and spectrometers. (auth)

39287 INVESTIGATION OF LIGHT EMISSION BY ELECTRON AVALANCHES IN BINARY MIXTURES WHERE XENON IS THE PARENT CONSTITUENT. ATTEMPTED INTERPRETATION OF THE VISIBLE CONTINUUM EMITTED BY XENON. Morucci, J. P.; Lansiart, A. (CEN de Saclay, Gif-sur-Yvette, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 95-106(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

The development of ionization detectors in parallel plane geometry with a third electrode (which is transparent to electrons) for positional detection of gamma and x radiation is studied. A study of the light emission during electron multiplication in binary mixtures with xenon filling gas is presented. A coincidence measurement was made between the electric information constituted by the electrons of the avalanche head and the light information coming from the output slit of a grating monochromator. The ionization chamber was operated in the proportional mode, and an iodine-125 x-ray source was used. (W.H.K.)

39288 STATISTICS AND TIMING OF THE FIRST PHOTOELECTRON WITH A HIGH GAIN DYNODE PHOTOMULTIPLIER. Miehe, J. A.; Ambard, G.; Zampach, J.; Coche, A. (Centre de Recherches Nucleaires, Strasbourg-Cronenbourg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 115-24 (Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Various types of time interval distributions are calculated assuming a compound Poisson law for the photoelectron emission. The experimental results obtained with the high gain first dynode photomultiplier RCA C 31000 D are discussed with reference to and exponential illumination function. Time resolution curves are measured by performing first photoelectron triggering. (auth)

39289 LITHIUM DRIFTABILITY IN DETECTOR-GRADE GERMANIUM. Sher, A. H.; Coleman, J. A. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 125-9(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

The behavior of many germanium crystals during lithium-ion drift, in terms of compensated depth W as a function of drift time t, does not follow the prediction of the equation: $W = (2\mu_{Li}Vt)^{\frac{1}{2}}$. Modification of the lithium velocity expression to include the loss of mobile lithium ions during drift yields the expression: $W = [\mu_{Li}V\tau\,(1-e^{-2t/\tau})]^{\frac{1}{2}}$, which seems to describe satisfactorily the experimental results. In addition to the loss mechanism, the effect of oxygen on lithium-ion drift mobility is considered. (auth)

39290 RESTORATION OF LITHIUM DRIFTABILITY IN SOME VACUUM-GROWN GERMANIUM CRYSTALS FOR γ-RAY DETECTORS. Tavendale, A. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 130-8(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D C. See CONF-700301.

Germanium crystals used for γ-ray detectors frequently exhibit slow or non-uniform lithium-ion drift. The presence of oxygen is one known cause. However, it has been found in these laboratories that in large (~1 kg) germanium crystals grown by the Czochralski method under vacuum, the presence of a fast diffusing impurity (probably copper) also leads to variable drift. Normal, uniform drift in these crystals has been restored by using gallium-indium alloy as a getter at ~800°C. The method is described in detail and the effects on crystal resistivity, dislocation density, and lithium drift rate are presented. γ-ray detectors fabricated from gettered material show high resolution characteristics. (auth)

39291 EFFECTS OF OPERATING TEMPERATURE ON THE BEHAVIOUR OF SEMICONDUCTOR DETECTORS. Martini, M.; McMath, T. A.; Fowler, I. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 139-48(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

The similarity in behaviour shown by lithium-drifted germanium and silicon detectors in recent detailed studies of their spectrometer performance over a wide temperature range suggested a comparison with the effects of temperature on the operation of other types of semiconductor detectors. A summary of the data published in the literature on temperature effects in compensated (p-i-n) and non-compensated (p-n) detectors is presented. Conditions for optimum spectrometer performance and limits to operating temperature are discussed, from experimental results and theoretical considerations. (63 references) (auth)

39292 TRAPPING EFFECTS IN Ge(Li) DETECTORS AND SEARCH FOR A CORRELATION WITH CHARACTERISTICS MEASURED ON THE P-TYPE CRYSTALS. Henck, R. (Centre de Recherches Nucleaires, Strasbourg-Cronenbourg); Gutknecht, D.; Siffert, P.; De Laet, L.; Schoenmaekers, W. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 149-59 (Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Various Ge(Li) detectors showing trapping effects (low energy tailing for an applied field of 10^3 V/cm) with uniform γ-ray irradiation have been studied using a collimated beam of ^{137}Cs γ-rays. The following parameters have been determined: velocity, mobility, drift length, and carrier lifetime. For many samples, a good agreement between experimental measurements of charge collection efficiency with the position of irradiation and calculated curves is obtained demonstrating that the trap distribution is uniform. The carrier velocities and mobilities are practically not modified in the samples showing trapping effects, but the drift lengths are lowered and, as a consequence, the carrier lifetimes. Various measurements including infrared transmission spectra, etch-pit distributions, electron lifetimes have been made on the starting P-type crystals. Results are presented showing a valuable correlation between the electron lifetimes measured at 77°K by the pulse charge method and detector performance. (auth)

39293 Ge CRYSTAL GROWTH AND EVALUATION AS Ge(Li) DETECTOR MATERIAL. Wichner, R.; Armantrout, G. A.; Brown, T. G. (Univ. of Calif., Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 160-4 (Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

A comprehensive program of germanium single crystal growth and the evaluation of such material for use as Ge(Li) detectors is described. The effects of crystal growth parameters such as pull rate, cooling rate, crucible material, and atmosphere, among others, are analyzed by a number of techniques. These techniques include the standard etch-pit density, resistivity profile and minority carrier lifetime measurements as well as others which have been shown to be extremely useful in characterizing the quality of single crystal germanium for Ge(Li) detectors. (auth)

39294 SPECTRUM DEGRADATION EFFECTS IN Ge(Li) DETECTORS. Armantrout, G. A. (Univ. of California, Livermore); Thompson, H. W. Jr. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 165-75(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

The mechanisms responsible for the degradation of the performance of Ge(Li) detectors (which include the effects of uniform trapping, non-uniform trap distribution, and locally weak collection fields) are considered, and simulated spectra have been computed. Measurements have been made to identify these sources of degradation. The important results include a measurement of the effective capture cross sections of the most important traps and a determination of the main sources of non-uniform trap distribution and weak collection fields in Ge(Li) detectors. (auth)

39295 COLLECTION EFFICIENCY AND CHARGE CARRIER LOSSES IN COAXIAL AND PLANAR Ge(Li) DETECTORS. IN-

FLUENCE ON THE TIME RESOLUTION. Poenaru, D. N.; Stuck, R.; Siffert, P. (Centre de Recherches Nucleaires, Strasbourg–Cronenbourg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 176-86(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

A theoretical study of the charge collection properties of coaxial Ge(Li) detectors is presented. Normalized relationships are derived, which can easily be handled for a great number of practical cases. A geometrical factor $g = r_i/w$ (r_i-internal radius of the coaxial counter, w-depletion layer width) has been introduced. The case of planar detectors can be derived if great values are given to g. Calculations have been performed assuming a 1/r field variation, and a punctual single event gamma ray energy loss (electron-hole pair created in a point). Concerning the variation of the charge carrier drift velocity vs the electric field, two kinds of approximation have been used in the calculations: variable velocity (VVA) and constant velocity approximation (CVA). Trapping has also been taken into account by assuming an uniform distribution of trapping centers throughout the detector sensitive volume. For different interaction points, geometrical factors and trapping parameters, the relationships for the charge carrier collection efficiency (peak position of monoenergetic spectra in the case of a collimated radiation beam), as well as the shapes of current and charge pulses have been established and plotted. The prompt coincidence curves (using the charge pulse leading edge timing) are calculated by evaluating the probability distribution of the time at which the charge signal crosses a discriminating level. The influence on these curves of the geometrical factor, the discriminator level, the noise and the trapping parameters is taken into account and discussed. Finally time resolutions of coaxial and planar detectors are compared. (39 references) (auth)

39296 FANO FACTOR FACT AND FALLACY. Zulliger, H. R.; Aitken, D. W. (Stanford Univ., Calif.). Contract F44620-69-C-0042. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 187-95(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Over the years Fano factor measurements have been published which demonstrate a steady decline in the values with time. In fact, the reduction in these values is so monotonic that an extrapolation to 1980 suggests that the Fano factor is completely negligible, and that all (non-avalanching) ionization detectors should show nearly perfect resolution (and that—to avoid being tarred and feathered by our colleagues—we should hasten to move on to another research field). Obviously, this is not the actual case in nature, but in many of the previous works the value has been published as the Fano factor, justifying a healthy skepticism on our part. In this paper we try and show what we think has been happening; we derive from our own theory for ϵ (the average amount of energy expended in producing an electron-hole pair) expressions which suggest that the Fano factor in both silicon and germanium may be very nearly equal to 0.05; and we show with our experimental data, as well as with a reanalysis of the data of other workers, that experiment is very nearly approaching this value. Finally, in trying to reveal what we think we understand about the Fano factor situation, we also reveal the areas in which our understanding is very poor. These observations support the value of further properly corrected experiments and the need for further very basic theoretical work. (auth)

39297 Si(Li) COAXIAL DETECTORS. Kraner, H. W.; Boulin, C. A.; Wagner, S. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 215-20(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Lithium drifted silicon coaxial detectors have been fabricated from 19 mm diameter material with volumes up to 5 cm^3. Essentially single line response, the double escape peak, is observed for gamma rays interacting by pair production. Resolutions (FWHM) of 5 keV and approximately 10 keV have been observed for incident gamma rays of 2.62 and 7.64 MeV. Slices, 2 to 3 mm thick, have been taken from such coaxial detectors and used as low capacity, high resolution x-ray detectors. A FWHM of 300 eV has been obtained at 6.4 keV using a detector with an active area slightly greater than 200 mm^2. (auth)

39298 INFLUENCE OF TRAPPING AND DETRAPPING EFFECTS IN Si(Li), Ge(Li) AND CdTe DETECTORS. Mayer, J. W. (California Inst. of Tech., Pasadena); Zanio, K. R.; Martini, M.; Fowler, I. L. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 221-34(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Carrier capture and re-emission effects in semiconductor nuclear particle detectors are characterized by a trapping time τ^+ and detrapping time τ_D. Measurement of these quantities as a function of temperature gives information on capture cross-sections, σ, and activation energies, E_T. Trapping and detrapping processes are field dependent. These effects have been investigated in Si(Li) and Ge(Li) detectors and are discussed in relation to operating temperature and detector resolution. The performance of Ge(Li) and CdTe detectors is evaluated in view of the influence of trapping effects. (61 references) (auth)

39299 GAMMA RAY DETECTORS MADE FROM HIGH PURITY GERMANIUM. Baertsch, R. D.; Hall, R. N. (General Electric Research and Development Center, Schenectady, N. Y.). Contract AT(30-1)-3870. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 235-40(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

A solution regrowth technique for growing P^+ and N^+ contacts on high purity germanium is described. Copper contamination of the high purity germanium is minimized by using KCN to remove copper from the surface of the germanium and by the gettering ability of molten indium in contact with the germanium. Diodes with leakage currents as low as 3×10^{-11} amp for 2000 volts applied to a fully depleted 4 mm thick detector have been fabricated. Preliminary measurements show that the resolution obtained with these diodes is comparable to the best Li drifted germanium detectors at 60 keV and 122 keV. Diodes have been warmed to room temperature as many as five times with no degradation in resolution. (auth)

39300 NUCLEAR DETECTORS FROM CADMIUM TELLURIDE GROWN FROM A TELLURIUM SOLVENT. Bell, R. O.; Hemmat, N.; Wald, F. (Tyco Labs., Inc., Waltham, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 241-7(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Highly perfect and pure single crystalline CdTe, grown by the traveling heater method, has been used to fabricate gamma ray detectors. Using tellurium as the solvent, carrier concentrations as low as 5×10^9 have been obtained in as-grown material. The detectors were formed by using back-to-back Schottky barriers on opposite sides of the CdTe slice. Operation over the temperature range from +125 to −150°C has been observed. Excellent agreement of the experimental spectra with a theoretical model which considers the mean free drift length of both electrons and holes has been obtained. Although the energy resolution is not yet of spectroscopic quality, the detector performance is more than adequate for application to some practical devices. (auth)

39301 BIOMEDICAL APPLICATIONS OF AVALANCHE SEMICONDUCTOR DETECTORS. Hewka, P. V. (General Electric Co., Philadelphia); Huth, G. C.; Swinth, K. L. Contracts AT(30-1)-3246; AT(45-1)-1830. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 265-74(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

The development of silicon avalanche semiconductor detectors for use in nuclear medicine and radiobiology is discussed. Progress in transmission bone scanning, tumor detection and diagnosis, organ scanning by x-ray fluorescence techniques, tooth enamel density measurements, and water content and determinations using avalanche detectors is reviewed. The development of avalanche detectors for plutonium and uranium determination in wounds and for blood flow detection and mapping in the brain are discussed in some detail. (W.H.K.)

39302 SOLID STATE DETECTORS IN BEHAVIORAL STUDIES. Ewins, John H. (Solid State Radiations Inc., Los Angeles); Friedland, Stephen S.; Mayevsky, Avraham; Samuel, David. Contract AT(04-3)-627. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 275-81(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

The use of small solid state detectors for behavioral studies is described. These detectors can be inserted in holders cemented to the skull of freely moving animals thus enabling the determination of uptake of radioactive material in an area of the brain. By injecting ^{32}P labelled Na_3PO_4, the rate of incorporation of phosphate in the brain under different behavioral conditions such as sleep, anesthesia, learning, etc., can be followed. The advantages of this method are the repeated measurements on the same animal, the use of live animals for both psychological and physiological studies, the possibility of kinetic and turnover studies in the brain, blood, and in principle, other organs. Using the uptake of

^{32}P together with studies involving other isotopes such as the stable isotope ^{18}O, an estimate of the energy requirements of the brain can be made. The detector is a lithium drifted silicon device mounted in an electroform nickel tube of 2 mm O.D. and a wall thickness of ≈25 microns. The detector is coated with 3 microns of parylene and secured in the nickel tube with an RTV potting compound. The major components of the preamplifier are: an FET, a transistor, three resistors and three capacitors mounted behind the detector in the probe. Performance characteristics and results are described. (auth)

39303 TRANSVERSE-FIELD SILICON DETECTOR. Harvey, N. P.; Bernou, J. P. (Simtec Industries Ltd., Montreal). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 306-9 (Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

A new form of LiD silicon detector which combines the advantages of large sensitive depth (25mm), thin window (less than 0.5 micron), and rapid sweep-out (less than 50nS) is described. Construction details are given. The device is arranged so that the direction of field produced by detector bias is at right angles to the line of flight of the particles. A protected thin window is obtained by a silicon oxide process; active areas up to 200 mm^2 are achieved by use of two wafers, produced by the diffused-contact process, and placed face-to-face. Resolutions for medium energy protons have now been achieved of small fractions of one per cent. The device gives total energy measurements on alphas up to 200 MeV, and protons to 80 MeV. (auth)

39304 POSITION SENSITIVE PARTICLE DETECTION BY MEANS OF MULTIPLE DIODE ARRAYS. Brown, W. L.; Buck, T.M.; Gibson, W. M.; Kerr, R. W.; Lie, H. P. (Bell Telephone Labs., Inc., Murray Hill, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 329-36(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Multiple diode arrays of the type developed for optical image sensing in vidicon-type TV camera tubes have been investigated as two-dimensional position sensitive detectors of single charged particles. The approximately half-inch square arrays consist of more than 700,000 diffused silicon diodes. The array is read out by a scanning electron beam. With such a system we have observed individual pulses from helium ions, alpha particles, and fission fragments in the 0.5 to 50 MeV energy range. The spatial resolution of the system is observed to be about 30 microns for the lower energies. (auth)

39305 ENHANCEMENT OF ALPHA PARTICLE TRACTS IN CELLULOSE NITRATE USING ELECTRIC FIELDS. Crannell, Carol Jo; Crannell, Hall; O'Sullivan, Colm (Catholic Univ. of America, Washington, D. C.). Contract N00014-67-A-0377-0002. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 337-9(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

We have observed that the application of an electric field across samples of cellulose nitrate during irradiation by alpha particles enhances the formation of etchable tracks. The track formation efficiency has been studied as a function of the strength of the electric field for alpha particles energies from 2.75 to 5.0 MeV. Both the number of etchable tracks and the amount of damage along individual tracks have been found to be enhanced by the application of an electric field. Approximately the same enhancement is observed either if the field is applied during irradiation by alpha particles or if the field is applied, then turned off before the irradiation is initiated. It is hypothesized that phenomena, associated with corona discharge in the air near the surface of the dielectric sample, is responsible for the observed enhancement. The present results are dominated by chemical effects which eclipse any indication of enhancement due directly to the application of an electric field. (auth)

39306 SOME APPLICATIONS AND PROPERTIES OF ONE- AND TWO-DIMENSIONAL POSITION-SENSITIVE PROPORTIONAL COUNTERS. Borkowski, C. J.; Kopp, M. K. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 340-9(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

A new method was developed for determining the position of ionizing events by measuring the risetime of output pulses from detectors having high resistance collectors. Basically these detectors are distributed RC lines; information about the location of an ionizing event is obtained from the analysis of the frequency spectrum of the detector output pulse, and the energy loss of this event in the detector is measured by analyzing the amplitude of the same output pulse. Three typical prototype detectors were constructed and tested in a series of imaging and diffraction experiments using ionizing radiation. The spatial uncertainty for collimated ^{210}Po alpha particles was 0.15 mm fwhm for a 200-mm-long proportional detector. The spatial uncertainty for collimated 20-keV x rays was 0.5 mm fwhm for a 400-mm-long detector. A two-dimensional system using parallel wires was developed and evaluated. With only four preamplifiers and relatively simple shaping and timing circuitry, 24,000 resolution elements (measured at fwhm) were obtained with a 30-wire counter having a sensitive area of 75 × 120 mm^2. These position-sensitive detectors are well suited for application in the life sciences for the localization of radioactive tracers in medical studies or in the structure determination of large organic molecules, with x-ray or neutron diffraction; in fluorescent x-ray or neutron spectroscopy; small-angle scattering experiments with x rays or neutrons; magnetic spectroscopy of protons and other charged particles; two-dimensional chromatography; x-ray astronomy; and fission physics experiments. (auth)

39307 COMPUTER GENERATED THREE-DIMENSIONAL OSCILLOSCOPIC IMAGES AND ASSOCIATED TECHNIQUES FOR DISPLAY AND STUDY OF THE SPATIAL DISTRIBUTION OF PULMONARY BLOOD FLOW. Greenleaf, James F.; Tu, Juliana S.; Wood, Earl H. (Mayo Graduate School of Medicine, Rochester, Minn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 353-9(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Various isotope techniques are used in the study of blood flow in organs which produce three-dimensional spatial distributions of isotopes. Spatial distribution of pulmonary blood flow has been studied using scans of the external surfaces of the thorax of living dogs and chimpanzees as well as scans of cross sections of embedded lungs following embolization with isotope tagged microspheres using a computer driven scintiscanner. The large quantity and nature of data obtained from such studies have led to the development of a computerized technique for transforming this information into conceptually meaningful two- and three- dimensional display formats. Computerized visualization of the complete three-dimensional count rate surfaces of the isotopic emboli distribution and of lung outlines has been achieved on a computer driven oscilloscope through a surface shading and hidden surface removal technique which creates the illusion of three dimensions on a photographic image of the display. (auth)

39308 SOFT X-RAY STUDIES OF CHANNEL MULTIPLIERS AND MULTIPLIER ARRAYS. Parkes, W.; Gott, R.; Pounds, K. A. (Univ. of Leicester, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 360-6(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Measurements of pulse height distributions, gain, and photon detection efficiency have been made for channel electron multipliers in the soft x-ray region. In the case of channel arrays, double exponential pulse height distributions have been found, and contact noise problems encountered. The variation of detection efficiency with angle of the incident beam and the uniformity of gain and efficiency over the cathode face have been studied. Results are given of a preliminary investigation of array operating lifetime. The detection efficiency over the cathode of a coned single channel was measured, and a comparison for angular variation between coned and plain cathode detectors is presented. (auth)

39309 USE OF CHANNEL MULTIPLIER ARRAYS FOR ONE AND TWO DIMENSIONAL X-RAY IMAGE DISSECTION. Gott, R.; Parkes, W.; Pounds, K. A. (Univ. of Leicester, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 367-73(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Methods of one and two dimensional x-ray image dissection using a channel multiplier array are discussed in which the position of incidence of any detected photon can be found, within the limits of the electronic dead time. Results for one dimensional systems in which spatial resolutions of 50 μm have been achieved and of a prototype two dimensional system having a similar resolution are reported and further developments and alternative methods of dissection are considered. (auth)

39310 INSTRUMENT FOR DETECTING 44 TO 100 A COSMIC X RAYS. Yentis, D.; Vanden Bout, P. (Columbia Univ., New York). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 374(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

We have designed, built, and tested an instrument for flight in an Aerobee sounding rocket which will measure the intensity of diffuse cosmic x rays in the range 44 to 100 Å while avoiding the systematic problems associated with counter resolution, low-energy cosmic-ray electrons, and ultraviolet radiation. The instrument employs a single reflection off a parabolic mirror to eliminate all high-energy x rays and soft electrons. The detector is a gas-flow proportional counter with a thin polypropylene window. The window coating and counter design provide a very low ultraviolet sensitivity. (auth)

39311 AMPLITUDE DISTRIBUTIONS OF THE POISSON PROCESS TRANSFORMED BY SYSTEMS WITH MEMORY, WITH SPECIAL REFERENCE TO SHOT NOISE AND PILE-UP. Soucek, B.; Cimerman, M.; Breyer, B. (Brookhaven National Lab., Upton, N. Y. Inst. Ruder Boskovic, Zagreb). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 375-82(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Many physical and biological phenomena can be described through processes obtained by a transformation of the Poisson process. Such processes have been simulated by the computer for various amplitude distributions and response functions which are common for processing of signals from nuclear detectors. The following amplitude distributions have been analyzed: delta function, gaussian, exponential, rectangular, and typical nuclear spectra. The system impulse response functions can have arbitrary shapes, such as exponential, RC integrated and/or differentiated, cusp, bipolar, etc. The following cases have been analyzed: continuous time series; pulsed time series (pulsed accelerator case); pulse shaping networks for minimal distortions at high rates; pile-up rejection systems; shot noise; systems with finite resolving time. A large number of cases have been simulated and systematically investigated, and probability density functions for each case are shown. (auth)

39312 INVESTIGATION INTO THE HARMS DEAD TIME CORRECTION PROCEDURE FOR PULSE HEIGHT ANALYZERS USING MONTE CARLO MODELING TECHNIQUES. Masters, Christopher F. (Univ. of Missouri, Columbia); East, Larry V. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 383-9(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

An automatic dead time correction technique for multichannel pulse height analyzers that does not make use of the usual live time correction has recently been proposed by J. Harms. In order to study the validity of this new correction technique, a Monte Carlo code was written to simulate the response of multichannel pulse height analyzers, incorporating both the Harms and standard live time correction techniques, to a variety of pulse height spectra. Simulated pulse height spectra of the type one might encounter from nuclear radiation detectors under a variety of count rate conditions were generated by the code. It was found that the Harms correction technique gave valid results in all cases tested, whereas the standard live time correction technique did not work properly when the spectral shape changed drastically during the course of the measurement. (auth)

39313 DELAYED COINCIDENCE TIME RESOLUTION: NaI(Tl). Hohenemser, C.; Reno, R.; Mills, A. P. (Brandeis Univ., Waltham, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 390-404(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

For delayed coincidence experiments using NaI(Tl) scintillation counters, first photoelectron triggering (FPET) has been practicable since the advent of the RCA 8575. Using FPET, improved time resolution at low γ ray energies was first demonstrated by Lynch, who also described his results by a model that fails to take into account the photomultiplier response. Using FPET, we have done systematic experiments from 6 to 511 keV for three different crystal sizes. We describe our results quantitatively by a simple model that takes into account the statistics of photoelectron production and the photomultiplier response, similar to El-Wahab and Kane. From the model calculations, we conclude that with present photomultipliers and NaI(Tl) scintillators, further improvements in resolution cannot be expected. The major difficulty is not the light output of NaI(Tl), but the single electron response of the photomultiplier. (auth)

39314 PROBLEMS RELATED TO CHARGE COLLECTION VARIATIONS IN Ge(Li) DETECTORS WITH SPECIAL REFERENCE TO TIMING. Balland, J.-C.; Pagnotte, Y.; Samuell, J.-J.; Sarazin, A. (Univ., Lyon). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 405-24(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

With the maximum likelihood method we have determined, in the case of Ge(Li) detectors for a random shape (but single interaction) and noise, the expression of the likelihood functions. If an electronic system could give this function as response to Ge(Li) pulses it would be the best pulse processor, but it is obviously impossible to realize. However the method gives the bounds of accuracy of measurements theoretically possible. For planar pulses, this bound is found to be proportional to the inverse of the expectation of the energy of the delivered current. For coaxial pulses, one derives bounds in low and high electric field regions. Results are not so simple as in the previous case and additive terms appear in the formulas with the expectation of the energy of the current. Rather surprising results are obtained: timing nearly as good for planar pulses could be approached. (auth)

39315 NOISE STUDIES OF CERAMIC ENCAPSULATED JUNCTION FIELD EFFECT TRANSISTORS (JFETs). Kern, H. E.; McKenzie, J. M. (Bell Telephone Labs., Inc., Murray Hill, N. J. Bell Telephone Labs., Inc., Whippany, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 425-32(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

In low noise preamplifiers for nuclear and x-ray spectroscopy, a major source of electronic noise is the lossy glass insulator in the header of the input junction field effect transistor. Substitution of low loss ceramic headers for glass headers and encapsulation with unselected Union Carbide and Texas Instruments 2N 4416 JFET chips decreases total preamplifier electronic noise from 330 eV to 200 eV $(FWHM)_{si}$ at room temperature. Further reduction in noise is accomplished by cooling the JFET. Preamplifier noise decreases to 125 eV for the TI JFET and to 160 eV for the UC JFET at their optimum temperatures. These noise values were obtained with a feedback resistor and with 4 μsec RC main amplifier pulse shaping time constants. The TI JFET exhibits a narrow minimum in its noise vs temperature curve, therefore it is essential that temperature be controlled quite precisely. A JFET temperature control system is described. Additional results concerning chemical contamination of JFET silicon chips by glass headers are presented. Finally, a method of decreasing noise still further by eliminating the feedback resistor and by using a pulsed light feedback system is discussed. (auth)

39316 CHARGE AMPLIFICATION WITHOUT CHARGE LEAK RESISTOR. Radeka, V. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 433-9(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Charge amplification without the conventional charge leak resistor is considered. It is shown that any charge leak mechanism based on continuous conduction current would contribute noise. Pulsed conduction of current from the amplifier input avoids this problem. A method for pulsed removal of charge is proposed, based on charge pumping via the detector capacitance and the gate-channel junction of the input field-effect transistor. In this configuration the detector is the only component connected to the gate of the field-effect transistor, and these two are the only components required to be in the cryostat. The detector capacitance serves also as feedback capacitance. (auth)

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Refer also to abstract 39389.

39317 (COO-1105-154) NINE YEAR REVIEW OF THERMOLUMINESCENCE DOSIMETRY RESEARCH AT THE UNIVERSITY OF WISCONSIN, 1961-1970. Cameron, John R. (Wisconsin Univ., Madison). Jul 1970. Contract AT(11-1)-1105. 35p. Dep. CFSTI.

Thermoluminescence research at the University of Wisconsin from 1961 to 1970 is reviewed. Graduate students who have contributed to thermoluminescence research are listed. Also, publications, workshops, and courses are given. (W.H.K.)

39318 (INR-1182) APPLICATION OF GRIDDED IONISATION CHAMBER FOR ALPHA SPECTROSCOPY. Kempisty, T. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 14p. (In Polish). Dep. CFSTI (U. S. Sales Only).

The results of an investigation on a gridded ionization chamber for alpha particle spectroscopy are presented. To establish the optimum operating conditions, certain parameters were measured. The energy resolution for ^{239}Pu alpha particles E = 5.157 MeV is 1.5%. (auth)

39319 (SC-RR-70-251) THEORY AND APPLICATION OF THE GENERALIZED SPECTRA CODE. Halbleib, J. A. Sr. (Sandia Labs., Albuquerque, N. Mex.). Apr 1970. 34p. Dep. CFSTI.

A discussion is given of the solution of a matrix approximation to the coupled system of Fredholm integral equations of the first kind as they represent the spectral unfold problem. This theory is incorporated into a generalized version of the computer code SPECTRA which treats the problem for an arbitrary finite dimensioned response matrix. The solutions generated by this code are discussed in relation to Lagrangian multiplier, least squares, and generalized inverse techniques. Results are presented which deal with various aspects of the application of the code to an overdetermined system. (auth)

39320 EVALUATING A MAGNETIC FIELD COMPONENT FROM BOUNDARY OBSERVATIONS ONLY. Wind, H. (CERN, Geneva). Nucl. Instrum. Methods; 84: 117-24(1970).

From Maxwell's equations, it follows that a magnetic field, in a vacuum, is fully determined by its boundary values. If boundary observations are fitted with a model obeying the known constraints, the difference between the real and the fitted field must reach its maximum at the boundary. Theoretically therefore the optimal method is to measure a field component at the boundary. A method is given here to solve the above boundary problem. It is assumed that a function with zero Laplacian is known at rectangular grid points at the six boundary planes of a rectangular box. The solution is given as expansions in trigonometric and hyperbolic functions. This method has been applied to several spectrometer magnets. Because the model is essentially orthogonal, the evaluation of the coefficients requires very little computing time (20 sec of CDC 6600 time to evaluate 1200 coefficients from 14,000 boundary observations of one component). To derive the field rapidly at any point, a three-dimensional grid, sufficiently dense for linear or quadratic interpolation, can be generated. (auth)

39321 GAMMA RAY ENERGY STANDARDS BELOW 100 keV. Nelson, G. C.; Saunders, B. G. (Univ. of California, Livermore). Nucl. Instrum. Methods; 84: 90-2(1970).

The energies of 10 gamma rays between 26 and 100 keV have been precisely determined with a Cauchois-type bent-crystal spectrometer. These values provide precise energy standards for low energy gamma-ray spectroscopy. (auth)

39322 A PROTON RESONANCE MAGNETIC FIELD STABILIZER USING A QUARTZ STABILIZED REFERENCE FREQUENCY. Breonce, P.; Grennberg, B. (Bureau International des Poids et Mesures, Sevres, France). Nucl. Instrum. Methods; 84: 83-9(1970).

An NMR stabilization for an electro-magnet has been built. The NMR frequency is held at a pilot frequency derived from a quartz oscillator. The unit is being used for fields between 0.7 and 1.0 T. Stability near the probe has been found as good as the quartz oscillator ($\pm 10^{-6}$). Hartree mean values for semicircular trajectories have been observed to keep within $\pm 5 \times 10^{-6}$ for days. (auth)

39323 ENERGY-ANALYZING MULTIPLYING SEMICONDUCTOR DETECTOR FOR LOW-ENERGY GAMMA SPECTROSCOPY AT ROOM TEMPERATURE. Ruge, I.; Berg, G.; Heuberger, A. (Technische Hochschule, Munich). Nucl. Instrum. Methods; 84: 55-60(1970). (In German).

Spectroscopy of γ-quanta with large area silicon-detectors (≈ 1 cm^2) has a lower limit of about 40 keV (fwhm $\approx$ 20 keV) at room temperature. This limit can be lowered considerably by using multiplying detectors, which amplify the signal fully but not all of the noise components. Obviously, preamplifier noise does not depend on multiplication and also according to the individual geometry of the diode the noise of the reverse current is not multiplied up to 90% in silicon ($\alpha \gg \beta$). In spite of the statistical Fano-noise and two other contributions it is possible therefore to lower this limit down to about 1 keV for quantum spectroscopy. These two additional noise contributions are generated by the statistical character of the multiplication itself and by local fluctuations of the multiplication factor owing to diode inhomogeneities; their influence on the signal to noise ratio (snr) is observed to be important only for greater multiplication factors for higher γ-energies. The individual noise contributions were measured in detail. Considering all noise components, the optimal multiplication factor was found to be about 20. For greater multiplication factors the snr decreases. This agrees with experiment. (auth)

39324 GAMMA SPECTROSCOPY WITH SEMI-INSULATING CADMIUM TELLURIDE. Zanio, K.; Montano, H. (Hughes Research Labs., Malibu, Calif.). Appl. Phys. Lett.; 17: 49-51 (15 Jul 1970).

Surface barrier detectors were fabricated from vapor-grown semiinsulating CdTe. Photopeaks were well resolved at room temperature and at 90% charge collection efficiency for γ emitters ranging from ^{57}Co (122 keV) to ^{60}Co (1.17 and 1.33 MeV). Although a resolution of 16% (FWHM) could be attained with ^{137}Cs (662 keV), the 1.17- and 1.33-MeV peaks from ^{60}Co could not be separated. (auth)

39325 PLANAR PAIR GEOMETRY FOR Ge(Li) DETECTORS. Baum, J. J.; Helenberg, H. W. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 33-8(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Some of the more desirable features of large volume coaxial and smaller volume planar detectors are combined in a planar pair configuration of planar lithium drifted germanium diodes. The present work examines some of the more important considerations involved and presents data obtained using a 27 cm^3 planar pair with energy resolution of 3.0 keV FWHM at 1.33 MeV. (auth)

39326 HIGH-SENSITIVITY PARTICLE SPECTROMETER FOR THE MEASUREMENT OF POLAR-CAP-ABSORPTION EVENTS. Bakke, J. C.; Reagan, J. B.; Reed, R. D.; Imhof, W. L.; Matthews, J.D. (Lockheed Palo Alto Research Lab., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 91-6(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A hybrid particle spectrometer possessing high-sensitivity and high-time resolution for the measurement of precipitating protons, electrons, and alpha particles during Polar-Cap-Absorption (PCA) events has been successfully operating in space aboard the OV1-18 satellite since 23 March 1969. Detection of protons in the energy range 1.2 to 46 MeV and integral above 70 MeV, electrons in the range 0.4 to 1.9 MeV and alpha particles in the range 7 to 20 MeV is performed with sensitivities as high as 0.1 particle/cm^2-sec and with a dynamic intensity range of six decades through the use of a transmission solid-state detector in conjunction with a total-energy, plastic-scintillation detector. Acceptable pulses from each detector, as determined by various combinations of coincidence logic, are analyzed with separate 15-channel pulse-height analyzers of the analog-to-digital type. A detailed description of the spectrometer, including a unique biasing technique which maintains a constant potential across the solid-state detector, independent of leakage variations due to temperature and radiation damage, will be given. Some typical characteristics of the particles measured during several PCA events will also be presented. (auth)

39327 PROTON SPECTROMETER FOR NASA'S APOLLO APPLICATIONS PROGRAM. Guenther, Godehard A. (Univ. of Alabama Research Inst., Huntsville); Oran, William A.; Parnell, Thomas A. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 117-29(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A high counting rate particle detector is described to measure trapped protons from 18.5 MeV to 400 MeV and electrons from approximately 1.2 MeV to 10 MeV. The instrument is a directional dE/dx-E telescope composed of solid state and scintillation counters with an acceptance angle of 45° and an energy independent geometric factor of approximately .4 cm^2 sterad. The dE/dx detectors are fully depleted silicon surface barrier detectors of 500 micron thickness and 3 cm^2 area. The energy detector is a sodium activated cesium iodide crystal of 100 MeV thickness for protons. A plastic scintillator is used as an anticoincidence shield. The detector design, electronics system, and calibration data for protons are presented in this paper. (auth)

39328 DIGITAL CLOSED-LOOP CALIBRATION SYSTEM FOR SPACE-BORNE PARTICLE SPECTROMETERS. Streeter, Gary R. (Space and Tactical Systems Corp., Burlington, Mass.); Guenther, G. A. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 124-9(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017(Pt.1).

The operation of a closed-loop, in-flight calibration system is described. This system utilizes a cesium iodide crystal with a grown-in ^{241}Am source as the calibration reference and a programmable photomultiplier dynode supply as the gain-change element. Through the use of this system, the overall gain of a particle spectrometer is expected to be kept accurate to within 3% throughout the changing orbital environment. Approximate power consumption of the system, including the dynode supply, analog section and digital sectoring and control is 415 milliwatts. (auth)

39329 SEMI AUTOMATED COMPUTER SYSTEM FOR GAMMA RAY SPECTRUM ANALYSIS OF THERMAL NEUTRON-

ACTIVATED SAMPLES. Pagden, I. M. H.; Pearson, G. J.; Beck, V. N. (Bedford Inst., Darmouth, Can.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 211-17(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A set of consecutively executed computer programmes has been developed for the quantitative interpretation of gamma ray spectra obtained with Ge(Li) detectors. The method compares spectral information with catalogued nuclear data and yields least squares fitted sets of activity which subsequently may be converted to parent masses. Results are presented for samples of unknown trace element composition and for spectra synthesized from the spectra of neutron irradiated high purity samples of elements and their oxides. (auth)

39330 RESOLUTION FUNCTION FOR DIGITALLY STABILIZED NUCLEAR SPECTROMETERS. Hewitt, J. S. (Univ. of Toronto). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 242-51(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A comprehensive control theory of digitally stabilized nuclear spectrometers has provided a quantitative basis for the optimal selection of various system parameters. The theoretical predictions are compared with measured resolution functions for a stabilized Ge(Li) photon spectrometer. Implications for stabilizer design are discussed. (auth)

39331 OVERLOAD RECOVERY CIRCUIT FOR CHARGE AMPLIFIERS. Radeka, Veljko (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 269-75(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The operation of low noise charge preamplifiers under high instantaneous pulse rates—"bursts"—is considered. An overload recovery circuit employing a field-effect transistor as the switch for the recovery current is described. The overload charge generated in the detector by the radiation burst in a time short compared to the small signal resolving time of the spectrometer may be 10^5 or more times larger than the charge due to a single particle to be measured between the bursts. The recovery time of the charge amplifier with the recovery circuit is less than 10 μsec. With a conventional amplifier-filter, the recovery time of the system to within the noise level is 50 to 100 μsec. The increase in noise due to the recovery circuit corresponds to an increase in the input capacitance of the charge amplifier of 2 pF. (auth)

39332 DIRECT-COUPLED GAMMA-RAY SPECTROMETER FOR HIGH COUNTING RATES. Johnson, L. O.; Heath, R. L. (Idaho Nuclear Corp., Idaho Falls). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 276-84(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The full potential of high-resolution gamma-ray spectrometry with Ge(Li) detectors has been severely limited by degradation in the quality of the pulse-height spectrum at high input data rates. A direct-coupled system featuring peak pile-up rejection, tail pile-up rejection (baseline inspection), RC shaping and, uniquely, no baseline restoration or primary pulse train delay has been built. System results in terms of gamma-ray spectra as well as system philosophy and circuit design are presented. (auth)

39333 USE OF AN ENERGY DISPERSIVE X-RAY ANALYZER IN SCANNING ELECTRON MICROSCOPY. Elad, E. (Nuclear Diodes, Inc., Prairie View, Ill.); Sandborg, A. O.; Russ, J. C.; van Gorp, T. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 354-62(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The application of a high resolution semiconductor energy dispersive x-ray analyzer in scanning electron microscopy is described. Optimum specifications of an x-ray spectrometer for such application are outlined and various problems related to detection of low energy x-rays are discussed. Characteristic x-rays of elements down to oxygen were detected with the described system, making it useful for a variety of industrial and research applications. (auth)

39334 SEMICONDUCTOR X-RAY SPECTROMETERS. Cameron, J. F.; Ridley, J. D. (Nuclear Enterprises Ltd., Edinburgh). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 363-8(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

An outline is given of the techniques used in the manufacture of lithium drifted silicon and germanium detectors. With current techniques detectors having areas of 25–50 mm^2 and a few millimeters thick can be prepared to give a resolution of better than 300 eV. The main applications of these detectors in electron microprobe analysis and x-ray fluorescence analysis are reviewed. In these fields the ability of the detectors to measure simultaneously the fluorescent x-rays from a wide range of elements considerably improves the techniques and extends their use. Applications of instruments incorporating semiconductor x-ray spectrometers in the laboratory, in the field and on-line are reviewed. (auth)

39335 16,000 CHANNEL, 50 MHz TIME-OF-FLIGHT ANALYZER FOR HIGH DATA RATES. Hahn, Jack; Cucancic, Ladislav; Gillman, Cyril; Zidon, Amikam (Columbia Univ., New York). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 405-9(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A 16,000 channel time-of-flight analyzer is described. The time channels are divided into groups of 512 channels. Channel widths of 20 nsec or binary multiples thereof, up to 1280 nsec, may be independently selected for each group. The time information is stored in a 16 word derandomizing buffer capable of accepting new data every 20 nsec. The buffer empties into a computer, with 32K of core memory, which can accept a word of data every 800 nsec. For this emptying rate, losses due to buffer size will be less than 0.1% for random arrival rates up to 10^6 words/sec. (auth)

39336 LEAST SQUARES GAMMA SPECTRUM ANALYSIS WITH AUTOMATIC GAIN AND BASELINE COMPENSATION. Nelson, Christopher B. (Northeastern Radiological Health Lab., Winchester, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 428-35(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The usual least squares fitting technique for gamma spectrum analysis has been expanded to include the computation of gain and baseline shifts. An iterative nonlinear technique is used. Since the shifting parameters are determined from the sample spectrum, no additional calibration data are needed. Implementation provided fitting up to 14 standards using an 8K PDP-8 with DECtape. (auth)

39337 AUTOMATIC DATA COLLECTION FOR MOSSBAUER EFFECT SPECTROSCOPY. Vonderohe, R. H.; Aschenbrenner, R. A.; Jacobsohn, D. H. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 481-5 (Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

An automatic data collection system for four Moessbauer effect experiments has been implemented by Argonne National Laboratory utilizing a small general purpose digital computer and a special purpose interface. This system, being characteristic of open-loop, on-line systems, permits maximum utilization to be made of interface hardware to fully automate data collection from four simultaneous experiments, while the computer is in a "halt" condition or being utilized for background processing. Extensive consideration was given in the design of this system to achieve the most advantageous balance of hardware and software. (auth)

39338 PROPERTIES OF A NaI(Tl) TOTAL ABSORPTION SPECTROMETER FOR ELECTRONS AND γ-RAYS AT GeV ENERGIES. Hughes, E. B.; Ford, R. L.; Hofstadter, R.; O'Neill, L. H.; Otis, J. N. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 14-16 (Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Performance of a system of three optically coupled thallium-activated sodium iodide crystals for total absorption electron and gamma spectroscopy at GeV energies is described. (W.H.K.)

39339 STILBENE AND NE 213 CHARACTERISTICS RELATED TO THEIR USE FOR NEUTRON SPECTROSCOPY. Toms, M. Elaine (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 107-14 (Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

The pulse discrimination technique permits scintillators to be used for neutron spectroscopy, in the presence of gamma rays, to investigate a wide variety of problems. The influence of shape and size of stilbene and NE 213 scintillators on their gamma-ray and neutron efficiencies and on the shape correction has been investigated. The neutron efficiency and the shape correction factor enter into the spectrum conversion function which is needed to reduce a recoil-proton energy distribution to a neutron spectrum.

Gamma-ray and neutron efficiencies from 0.1 to 24 MeV have been graphed as a function of length. Graphs of the shape correction factor and the spectrum conversion function, up to 24-MeV neutron energy, have been made for various dimensions and similar volumes. These graphs and the summary tables can be used to select the size and shape of a detector to minimize the spread of the correction factor over a given range of neutron energy and to increase the neutron efficiency consistent with conditions of a given experiment or application. (auth)

39340 IMPACT OF SEMICONDUCTOR DETECTORS ON X-RAY SPECTROSCOPY. Walter, F. J. (ORTEC, Inc., Oak Ridge, Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 196-214(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

The impact of semiconductor detectors on x-ray spectroscopy is reviewed with particular emphasis on areas where this technique promises significant advantages. Applications in the fields of scanning electron microscopy, electron microprobe analysis, x-ray diffraction, x-ray fluorescence analysis, and x-ray astronomy are described. The effects of various detector system performance parameters such as resolution, count rate capability, stability, efficiency, etc., on the analytical usefulness of the system are examined in detail. The fundamental and practical state-of-the-art limitations on detector system performance are discussed in terms of their present and future impact on the usefulness of the energy analyzing technique for x-ray spectroscopy. (53 references) (auth)

39341 DERIVATION OF THE ASYMMETRY RATIO FOR A PLANAR Ge(Li) GAMMA RAY POLARIMETER. Martin, Robert (Johns Hopkins Univ., Baltimore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 248-53(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

The integral expression, which gives the probability of a scattered gamma ray causing a coincidence count between the center and one of the side detectors, is derived using the assumptions of only a Compton scattering in the center detector and a photoelectric reaction in one of the end detectors, the necessity of leaving at least the minimum detectable amount of energy in both detectors, and the fact that only a certain proportion of the gamma rays leave the center detector with just one scattering; secondary scattering has not been included in this calculation. The calculated asymmetry for the incident energy range .42 to 1.36 MeV agrees well with the experimental result, and compares favorably with those calculated by Metzger and Deutsch for more conventional polarimeter designs. (auth)

39342 SEPARATELY HOUSED Ge(Li) DETECTORS OPERATING IN PARALLEL AND AS A SUMMING COMPTON SPECTROMETER. Larsen, R. N.; Strauss, M. G. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.,, Trans. Nucl. Sci.; NS-17: No. 3, 254-64(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Coaxial as well as planar Ge(Li) γ-ray detectors housed in separate cryostats have been operated in parallel and as a summing Compton spectrometer. The linear signals from two detectors were direct coupled into a single charge-sensitive preamplifier, thus eliminating the need for matching electronic gain and linearity of two separate channels. The full-energy peak efficiency of two parallel coaxial detectors is nearly equal to the sum of the efficiencies of the individual detectors. Similar increase in efficiency was also observed for double-escape peaks when two small planar detectors were paralleled. The FWHM of the 1.33 MeV ^{60}Co line was 2.94 keV in the parallel mode as compared with 2.23 and 2.38 keV for the constituent 22cc coaxial detectors. When the latter detectors were used as a summing Compton spectrometer, the Compton edge was completely eliminated. The peak-to-Compton ratio in a ^{137}Cs spectrum was 25 : 1 in the singles mode and 125 : 1 in the coincidence mode. However, in the complex Th C'' spectrum the Compton spectrometer was not very effective in resolving a weak low energy line from the continuum of several intense γ-rays of higher energy. Thus, one large, high resolution detector or several in parallel is not only simpler and more efficient, but may also be more effective than the summing Compton spectrometer. (auth)

39343 LARGE DIAMETER GERMANIUM CRYSTALS FOR GAMMA-RAY SPECTROMETRY. Dearnaley, G. (Atomic Energy Research Establishment, Harwell, Eng.); Gibbons, P. E.; Ellis, R. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 282-6(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

The progress made in the development of large diameter germanium crystals for gamma-ray spectrometry is reviewed. These are vacuum pulled and have been shown to be consistently free of oxygen. Planar devices of 40 sq. cm. area and depletion thickness of 8 mm have given an energy resolution better than 3.7 keV at 1.33 MeV. The relationship between detector performance and crystal properties is examined for possible correlation. (auth)

39344 PERFORMANCE OF CdTe AS A GAMMA SPECTROMETER AND DETECTOR. Zanio, K.; Neeland, J.; Montano, H. (Hughes Research Labs., Malibu, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 287-95(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

The gamma response of CdTe surface barrier detectors fabricated from semi-insulating material is analyzed. Small devices (10 mm^3 to 15 mm^3) from vapor grown crystals are capable at room temperature of resolving photopeaks at 90% charge collection efficiency for gamma emitters ranging in energy from 122 keV for ^{57}Co to 1.33 MeV for ^{60}Co. A resolution of 16% (FWHM) has been obtained with ^{137}Cs (662 keV). Incomplete charge collection due to heavy trapping degrades resolution and limits the size of present devices. Larger devices (≈1 cm^3) prepared from melt crystals, although quite efficient to gammas (80% to ^{60}Co), cannot resolve photopeaks. Their performance for straight counting applications is limited by a temperature dependent count rate, polarization at low temperatures, and thermal noise at high temperatures. Detrapping of electrons and holes is necessary to prevent polarization at low temperatures and may be useful in extending the high temperature limit. (auth)

39345 MONTE-CARLO ANALYSIS OF THE Ge(Li) DETECTOR USED IN THE SUM-COINCIDENCE MODE. Walker, D. M. (Georgia Inst. of Tech., Atlanta); Palms, J. M. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 296-305 (Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

A Monte-Carlo model for investigating sequential gamma scattering and for predicting sum-coincidence and sum-only detector performance has been developed in order to assess the Compton suppression capabilities of Ge(Li) detectors which accept only multiple gamma interaction sequences. Calculated performances for a concentric cylindrical detector shows good agreement with experimentally observed sum-coincidence spectrometer (SCS) behavior. Calculations were made for hypothetical germanium detectors of cylindrical volumes from 7.1 cc. to 28.3 cc., and for gamma energies of 320 keV to 2754 keV. The requirement of multiple scattering is shown to eliminate only a minor portion of the total-energy gamma events. Effects of detector volume are characterized, and the location and thickness of dead layers separating active detector regions are shown to be important to SCS performance. Calculations of the energy partitioning between detector volumes for coincidence events indicate that the "backscattering" mode is not the dominant mechanism for good event sequences as has been postulated, and that good and bad event sequences are highly localized on the two-parameter spectrum of the energy output from each detector for coincidence events. The relationship of the calculations to detector performance is given. (auth)

39346 FOUR INPUT MULTIPLEXER FOR TWO-DIMENSIONAL GAMMA-RAY SPECTROMETRY. Connally, R. E.; Mitzlaff, W. A.; Brauer, F. P. (Pacific Northwest Lab., Richland, Wash.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 440-5(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

The use of two-dimensional gamma-ray spectrometry is becoming a standard radiochemical technique for the analysis of cascaded gamma emitters. Coincidence and noncoincidence events from a sample station detector pair are usually stored and displayed in a rectangular data array. Half of this array is redundant if both detectors are identical and matched as to energy response, and another half of the array may be nonessential if the energy scale is adjusted so that all sum peaks of interest have a total energy that is less than the full scale energy of the X and Y axes. The four input multiplexer is a digital device which allows one to feed pulses from four two-dimensional sample stations into one ADC pair and 4096 memory and still record all essential data. Further, the noncoincident data from each sample station is recorded in 240 channels to provide improved singles energy resolutions. (auth)

39347 AUTOMATIC PROCESSING OF DIODE SPECTROMETRY RESULTS. Philippot, J. Cl. (CEA, Orsay, France). IEEE

(Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 446-88(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Data preparation and processing techniques for automatic processing of semiconductor gamma spectrometer data are described. Considerations for preparation of the data, including standard information, physical data, and detector efficiency, are discussed. The principle of the line and a detailed description of the computer program are presented. (W.H.K.)

39348 METHOD FOR SEMI-AUTOMATICALLY GENERATING NaI(Tl) SPECTROMETER RESPONSE FUNCTION MATRICES. Steyn, J. J. (NUS Corp., Rockville, Md.); Harris, D. W. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 489-94(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

A method for semi-automatically generating sodium-iodide scintillation spectrometer response function matrices is presented. Experimental standard source spectra were used to systematically obtain normalized Compton continua. The normalized continua were indirectly interpolated to obtain the desired response function matrix. The standard source normalization and the indirect interpolation was carried out through the use of a comprehensive pulse-height gain-changing algorithm. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 40227, 40234, 40293, and 40484.

39349 (PURC-2137-22) A WIRE-SPARK-CHAMBER SYSTEM WITH ON-LINE COMPUTERS. Technical Report No. 7. Ford, W. T.; Piroue, P. A.; Remmel, R. S.; Smith, A. J. S.; Souder, P. A. (Princeton Univ., N. J. Dept. of Physics). 27 May 1970. 14p. (CONF-700323-1). Dep. CFSTI.

From 10th International Conference on Data Handling Systems in High Energy Physics, Cambridge, England.

The performance of a system of wire spark chambers and 2 on-line computers (one being time-shared) used in an experiment at the Brookhaven A.G.S. to study the decay of $K^{\pm}$ mesons via the τ mode ($K^{\pm} \rightarrow \pi^{\pm}\pi^{+}\pi^{-}$) is described. (auth)

39350 (SLAC-PUB-765) PERFORMANCE OF THE SLAC SPIRAL READER. Loos, J. S.; Leith, D. W. G. S. (Stanford Linear Accelerator Center, Calif.). Jun 1970. 10p. (CONF-700902-2). Dep. CFSTI.

From International Conference on Instrumentation for High Energy Physics, Dubna, USSR.

The general performance of the SLAC spiral reader is presented. We discuss the following topics: (1) detailed comparisons to measurements on conventional machines in terms of physics output and measurement accuracy; (2) an evaluation of peak and averaged measuring rates; and (3) a brief description of hardware development work in progress. (auth)

39351 A NOVEL METHOD FOR ANALYSIS OF NUCLEAR EMULSIONS EXPOSED TO HIGH FLUX. Coupat, B.; Michel, B.; Montret, J. C.; Vazeille, F. (Laboratoire de Physique Nucleaire Fondamentale et Developpement, Clermont-Ferrand, France). Nucl. Instrum. Methods; 84: 125-8(1970). (In French).

Nuclear emulsion technique is particularly suitable, under certain conditions, to study physical processes occurring with small cross sections. However, to avoid misinterpretation of false events one must define very strict selection criterions. We describe in this paper the criterions we chose to analyse inelastic scattering of muons of 6 and 12 GeV/c in nuclear emulsions exposed at high muon fluxes. (auth)

39352 AUTOMATIC SCANNING AND MEASUREMENT OF BUBBLE CHAMBER FILM ON POLLY II. Allison, W. W. M.; Beck, F.; Hodges, D.; Loken, J. G.; Musgrave, B.; Phillips, H. B.; Royston, R.; Sunde, R. A. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 84: 129-37(1970).

An exposure of 600,000 hydrogen bubble chamber pictures of 2.3 GeV/c $\bar{p}p$ interactions in the 30-inch Argonne-MURA chamber is being scanned and measured for 2, 4, 6 and 8 prong interactions by POLLY II, a computer-controlled CRT device. The performance of the automatic scanning and measuring is assessed on the basis of the first 160,000 events processed. The control program searches for beam tracks and finds interactions without prescanning. It digitises the tracks, measures bubble density and outputs master point information ready for direct input to the geometrical reconstruction program. The operator is an integral part of the system and is available to give assistance when required. Film is processed at 70–100 events per hour. (auth)

39353 NEW READ-OUT METHOD FOR WIRE SPARK CHAMBERS OPERATING IN MAGNETIC FIELDS. Kullander, S.; Landaud, G.; Lorenzi, R.; Yonnet, J. (CERN, Geneva. Univ., Caen, France). Nucl. Instrum. Methods; 84: 138-40(1970).

A lumped delay line is used for read-out of a wire spark chamber. Preliminary measurements give a precision better than 0.5 mm and show that multiple sparks can be detected. (auth)

39354 HIGH PRECISION DIGITAL POSITION CONTROL SERVO SYSTEM. Zivkovic, D. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods; 84: 13-20(1970).

A digitised projection microscope used for bubble chamber film measurement has a precision digital servo system to control the stage movements. The servo is controlled by means of a rotating "tracker ball." The accuracy of positioning, as well as the stability of the system, is within 2 μm mechanical movement. The servo incorporates both manual and automatic change of electronic "gear ratio" and provides for positioning to within 8 μm by digital computer command. (auth)

39355 MECHANISM OF FORMATION OF SPARKS IN A SPARK CHAMBER. Rudenko, N. S. Zh. Tekh. Fiz.; 40: 1028-32(1970). (In Russian).

Fukui and Miamoto attributed the formation of sparks in a spark chamber to the creation of avalanches at the tracks; these avalanches reach critical dimensions, at which the positive and negative regions of neighboring avalanches interact with each other. These so-called streamers probably act as conductors. The photoionization processes governing the increase in the ionization density in the streamer and spark stages are not sufficiently well known yet. It was concluded that the formation of sparks does not depend on the external field within the chamber. It was not found possible to determine the limiting angle involved in the formation of the sparks. There was a smooth passage from sharply defined sparks at low angles toward generalized background luminescence at high values of the angle. Decrease of the avalanche density in the tracks results in a decrease of the interaction forces of space charges. The photographs taken revealed that the streamers fuse into each other when distances between them still exceed their cross section. (TTT)

39356 FAST LOGIC SYSTEM FOR GEOMETRICAL SELECTION OF SPARK CHAMBER TRIGGERS. Dhawan, S. (Yale Univ., New Haven, Conn.); Rothberg, J. E. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 410-15 (Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A fast parallel logic system employing MECL II integrated circuits with a total analysis time of about 100 nsec was used to preselect elastic scattering events in a K-p scattering experiment. A ninety counter scintillation hodoscope arranged in banks of ten counters each allowed the selection of events on the basis of (a) the presence of exactly two outgoing particles; (b) coplanarity of outgoing particles with respect to the incoming beam; and (c) approximate agreement of outgoing angles with calculated kinematic requirements. About 3% of candidate events satisfied this set of restrictions and initiated spark chamber pulsing and data transfer to a computer. (auth)

39357 OPERATING EXPERIENCE WITH A MODULAR DIGITAL DATA SYSTEM FOR HIGH ENERGY PHYSICS. Droege, T.; McFadden, J.; Wash, S.; VonColln, R. (Princeton-Pennsylvania Accelerator, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 445-51(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A modular digital data system originally designed for magnetostrictive wire spark chambers has been expanded to include most digital high energy physics data. The system is built around a 12 bit data bus and has been implemented for a number of computers and other output devices. This paper summarizes three years of operating experience. (auth)

39358 SOME THOUGHTS ON THE DATA ACQUISITION PROBLEM OF HIGH-ENERGY PHYSICS EXPERIMENTS. Kirsten, Frederick A. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 452-7 (Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Some of the questions that arise when considering a standard data-bussing system are discussed. The discussion is restricted to applications in high-energy physics instrumentation. It is pointed out that it is necessary to provide for the operation of such systems without on-line computers. CAMAC, NIDBUS, and NIM are considered. (auth)

39359 APPARATUS FOR THE EXAMINATION OF PHOTOGRAPHS. (to Commissariat a l'Energie Atomique). British Patent 1,194,241. 10 Jun 1970. Priority date 15 Jun 1966, France.

An apparatus for the examination and analysis of photographs from Wilson cloud chambers and bubble chambers is described. The apparatus enables photographs to be projected on two different screens producing the same image at different enlargements and superimposes on the resulting images those of an indicator whereby an operator can follow a path and record the coordinates of a moving point in relation to exact reference points. These coordinates are then collected on punched cards or tapes and analyzed by computer. (C.E.S.)

39360 IMPROVEMENTS IN AND RELATING TO A SEALING DEVICE FOR A DOOR OR THE LIKE. (to Commissariat a l'Energie Atomique). British Patent 1,188,762. 22 Apr 1970. Priority date 9 Jun 1967, France.

A sealing device for a door, inspection window, or like enclosure that provides a permanent leak-tight connection irrespective of variations of pressure or temperature is described. The sealing device may be used particularly for bubble chambers. (C.E.S.)

39361 SOME PROBLEMS IN HIGH-ENERGY PARTICLE DETECTION AND ANALYSIS. Roberts, Arthur (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 7-13(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

The kinematic analysis of high-energy events requires, in general, particle momentum measurements with an absolute error of ±50–100 MeV/c, independent of momentum. Corresponding errors are 0.05% at 100 GeV/c, less at higher momenta. To minimize the cost of magnetic deflection of high-energy particles, improvements in angular precision, hence, in particle location accuracy, are desirable. The present analysis indicates that improving location accuracy from ±1/3 mm to ±0.1 mm is both desirable and feasible. The usefulness of still higher precision must await data on detailed systems performance. For complex events, it appears likely that vidicon digitization can compete favorably in cost, convenience, and flexibility with large wire-array systems. Also, neutral particle detectors that furnish accurate data on the location and direction of neutral particles (gamma rays, neutral hadrons) are likely to be important. (34 references) (auth)

39362 LARGE AREA HIGH RESOLUTION COSMIC RAY CHARGE COMPOSITION DETECTOR. Ormes, J. F.; Balasubrahmanyan, V. K.; Price, R. D.; Ryan, M. J.; Silverberg, R. F. (Goddard Space Flight Center, Greenbelt, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 17-23(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

A detector designed to study the charge composition of the primary cosmic radiation in the range Z = 3 to 30 has been flown on balloons during 1969. The flight is part of a program to study the charge composition in the energy range 10 to 10^3 GeV. The telescope consists of a four fold charge measurement using two plastic scintillators, a Cherenkov detector and a mosaic CsI (Tl) detector. The intrinsic limitations on charge resolution due to statistical fluctuations in energy loss are approached by correcting the pulse heights for geometrical effects. This is accomplished by calibrating the detector response in flight using a spark chamber to determine the particle trajectories. (auth)

39363 TRANSITION RADIATION AND ITS APPLICATION TO THE DETECTION OF SUPER-HIGH ENERGY PARTICLES. Yuan, Luke C. L. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 24-8(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

When a charged particle moving with uniform velocity v crosses the boundary between any two media with different dielectric constants, it will emit electromagnetic radiation, called transition radiation. The emitted frequency spectrum of the transition radiation covers from the optical spectrum up into the x-ray spectrum, the extent of which depends on the Lorentz factor, γ (= $1/\sqrt{1-\beta^2}$) of the moving particle. Theory predicts that the intensity of the transition radiation emitted in the optical region is proportional to log γ and that the intensity of the x-ray radiation is linearly proportional to γ. Experimental vertification of both these theoretical predictions is presented and possible application of the transition radiation for the measurement of the γ of super-high energy particles is discussed. (auth)

39364 PARTICLE IDENTIFICATION AT RELATIVISTIC ENERGIES BY THE USE OF SECONDARY EMITTERS. Llacer, J. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 29-42 (Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

The usefulness of negative electron affinity secondary emitters as detectors of particles in the high relativistic region is studied theoretically in detail. It is found that GaP(Cs) has poor secondary escape statistics, resulting in the inability to distinguish between 200 BeV/c protons and pions in single particle experiments. GaAs (Cs + [O_2 + Cs]) has good escape statistics, but its active depth may be too large, and density effects are expected to set in. A $GaP_{(1-x)} - GaAs_{(x)}$ heterojunction which could solve both problems is discussed. In any case, it is found that non-linear filtering of the near Landau distributed signals from secondary emitters is required in order to obtain useful particle discrimination. One feasible scheme is proposed which should allow separating 200 BeV/c protons and pions, for example, with 90% efficiency or better at near 100% confidence. (auth)

39365 WIRE SPARK CHAMBER SPECTROMETER WITH A CAPACITOR MEMORY AND FET READOUT. Coombes, R. (Stanford Univ., Calif.); Fryberger, D.; Piccioni, R.; Porat, D.; Dorfan, D. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 50-4(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

A 20-plane wire chamber spectrometer utilizing capacitors as memory elements and suitable for operation in a magnetic field is described. The (parallel) wire planes are separated by ~1 cm. The active areas of the chambers range in size from 120 × 120 cm^2 to 200 × 240 cm^2. The wire separation is 1 mm. Each readout wire is connected to a separate capacitor resulting in a 30 K-bit memory for the total system. Using FET's as gates, the capacitors are read out in 32 bit words. These words are formatted into data sets of 18 bits/spark and transferred to a PDP-9 computer. Digital processing of data is briefly described, including the computer interface and test procedures. Advantages of this system are discussed together with some performance characteristics. (auth)

39366 OPERATING CHARACTERISTICS AND APPLICATIONS OF MULTIWIRE PROPORTIONAL COUNTERS. Koester, L. J. Jr. (Univ. of Illinois, Urbana). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 55-9(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Multiwire proportional counters have proved to be very useful for a wide variety of experiments at all energies. Properties of these detectors essential in planning an experiment, e.g., their efficiency as a function of position and their output timing, have been measured. Integrated circuit amplifier-discriminators have been developed for use with multiwire arrays and operated in the typical large accelerator environment. An experiment on the scattering of pions and protons by complex nuclei has been performed with 8-inch square arrays of proportional counters used for x, y hodoscopes. (auth)

39367 NEW INSTRUMENT CONCEPT FOR GAMMA RAY ASTRONOMY. Favale, A. J. (Grumman Aerospace Corp., Bethpage, N. Y.); Schneid, E. J.; Hofstadter, R.; Hughes, E. B. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 67-70(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

A new instrument concept that utilizes the principle of the Total Absorption Shower Cascade (TASC) detector is proposed for gamma ray astronomy in space. Using the TASC detector to measure the gamma ray energy and wire chamber arrays to measure the incident angle, an instrument package designed to measure gamma rays having energies greater than 100 MeV is being proposed for a large satellite such as NASA's proposed High Energy Astronomy Observatory. The proposed instrument has a minimal flux sensitivity of 2×10^{-10} photons/cm^2 sr sec which will allow gamma rays with energies up to 10^4 GeV to be measured. An energy resolution (FWHM) for the TASC detector of ~1 percent at 10 GeV has been measured and an angular resolution of ~1 degree appears to be obtainable for the wire chamber arrays. (auth)

39368 UNDERWATER CHERENKOV LIGHT DETECTOR. Riel, Gordon K.; Cha, Moon H. (Naval Ordnance Lab., Silver Spring, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 350-2(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

An underwater Cherenkov detector has been tested. The results indicate that one phototube can observe about 100 m^3 of water target. Use of a light trap increases the effective area of the phototube, thus giving a uniform response within this volume. However, losses in the trap restrict counting to events of higher energy. (auth)

Radiation Dosimeters

Refer also to abstracts 39119, 39220, 39221, 39399, and 39459.

39369 (ORNL–4446, pp 251-70) APPLIED RESEARCH. Becker, Klaus; Boyett, R. H.; Chantanakom, Nongnooch; Cheka, J. S.; Crase, K. W.; Johnson, D. R.; Oberhofer, M.; Robinson, E. M.; Wilson, J. F. (Oak Ridge National Lab., Tenn.).

Research and developments in TSEE (thermally stimulated exoelectron emission) dosimetry are discussed including instrumentation, LET dependence of TSEE response, thermal stability (fading), pretreatment, and relation between TSEE and thermoluminescence. Recent developments in radiophotoluminescence and thermoluminescence are outlined. Also, nuclear track registration in polymers is discussed including the damage mechanism, automatic track counting, special applications of spark counting, and miscellaneous track studies. (W.H.K.)

39370 (ORNL–4446, pp 271-7) HPRR AND ACCELERATOR OPERATIONS. Haywood, F. F.; Ward, D. R.; Francis, R. A.; Gilley, L. W.; Poston, J. W. (Oak Ridge National Lab., Tenn.).

Radiobiological research at the HPRR (Health Physics Research Reactor) is summarized. Results of an international intercomparison of nuclear accident dosimetry systems are tabulated. Operations at the DOSAR Low-Energy Accelerator and the 3 MeV Van de Graaff accelerator for testing magnetic analyzing systems, radiation detectors, and dosimeters are briefly discussed. (W.H.K.)

39371 METHOD OF MANUFACTURING RADIATION INDICATOR OF PLASTICS MATERIAL. Matsumoto, Shoichi; Tsukada, Tomomichi; Umetsu, Kazuo; Fukaya, Hiroyuki (to Tokyo Shibaura Electric Co. Ltd. Toyo Chemical Co. Ltd.). British Patent 1,194,931. 17 Jun 1970. Filed 6 Sep 1967.

A method for the manufacture of plastic materials, which are sensitive to ionizing radiation and radiation indicators using such materials, comprises mixing a chlorine-containing polymer with not more than 3% by weight of an acid-sensitive dye, based on the weight of polymer, milling the hot roll mixture so that it undergoes a uniform thermal treatment, and then fabricating the rolled stock into the desired form ensuring that the whole of the batch is submitted to substantially the same thermal conditions. The indicator produced undergoes a distinct color change according to the radiation dose received, and if suitable calibration charts are prepared the received doses may be determined. The errors of measurement are much the same as, or less than, those of other dosimetric methods. Where an indicator has a relatively small light transmittance it is better to rely on its light reflectance to determine radiation doses. If more accurate measurements are required the light reflectance or transmittance of the indicator at the specific wavelength employed should first be determined and the measured values compared with those obtained with a control indicator. The chlorine-containing polymer may be a polymer or copolymer derived from such monomers as vinyl chloride, vinylidene chloride, vinyl acetate, and styryl chloride. A post-chlorinated hydrocarbon polymer may also be used. A list of acid-sensitive dyes is given. The mixture may also contain salts of Pb, Sn, Zn, or Cd, and various other listed additives. (UK)

39372 THERMO-LUMINESCENT MATERIAL FOR IONIZING RADIATION DOSIMETRY. Dajlevic, Radovan; Carpentier, Serge; Delarue, Roger; Francois, Henri; Portal, Guy; Pradel, Jacques; Soudain, Georges (to Commissariat a l'Energie Atomique). British Patent 1,195,521. 17 Jun 1970. Priority date 18 Jan 1968, France.

An inexpensive ionizing radiation dosimeter comprising a thermoluminescent material consisting of alumina grains in the form of α-phase crystals, which can be incorporated into building products such as bricks, tiles, and the like, is described. (C.E.S.)

39373 RADIATION DOSIMETERS. (to Inrescor Aktiengesellschaft fuer Industrielle Forschung und Strahlennutzung). British Patent 1,188,095. 15 Apr 1970. Priority date 29 Aug 1967, Switzerland.

A chemical dosimeter that employs the radiolysis of nitrate ions to nitrite ions for the measurement of ionizing radiation is described. The nitrite ions cause the formation of a dye, preferably an azo dye, whose optical density is a measure of the radiation dose. (C.E.S.)

39374 IMPROVEMENTS IN OR RELATING TO DOSIMETERS. Morris, Ann; Sheldon, Robert; Stapleton, Geoffrey Brian (to Science Research Council). British Patent 1,188,933. 22 Apr 1970. Filed 22 Aug 1966.

A dosimeter is described which is capable of measurements in the range 1 to 1000 MR. The instrument comprises a container in which is a solid material which on irradiation evolves a gas in quantity related to the radiation dose, together with means to indicate the pressure in the container. The solid material is conveniently polyethylene in the form of powder or film, in which case the evolved gas is H_2. The pressure indicating means may be a conventional gas pressure gauge, such as a Bourdon gauge, communicating with the interior of the container, or alternatively the container may be closed and the deflection of its walls, or of a diaphragm within the container, due to the gas pressure may be measured with strain gauges. The diaphragm may constitute one wall of the container. (UK)

39375 A METHOD OF READING PHOTOGRAPHIC DOSIMETERS AND APPARATUS FOR CARRYING OUT THIS METHOD. Marchal, Paul; Pascal, Andre; Portal, Guy; Talin, Pierre (to Commissariat a l'Energie Atomique). British Patent 1,191,731. 13 May 1970. Priority date 11 May 1966, France.

A method is proposed to improve the reading of photographic film dosimeters by reducing preparatory work to the programming of a single calibration curve per emulsion and by permitting direct reading of the doses corresponding to blackening. The apparatus for reading the films is also described. (C.E.S.)

Radiometric Instruments

Refer also to abstracts 39141 and 39246.

39376 (PRNC–135, pp 264-8) ELIMINATION OF MEASUREMENT INTERFERENCES FROM SURFACE-TYPE NUCLEAR SOIL DENSITY AND MOISTURE GAUGES. Gardner, Robin P. (North Carolina State Univ., Raleigh. Dept. of Nuclear Engineering).

From Radiation and isotope technology in Latin American development.

The sources of error in the nuclear soil density gauges are identified as: sensitivity to variations in sample composition, poor calibration technique, and sensitivity to surface heterogeneities. The errors associated with the nuclear moisture content gauges are identified as: sensitivity to soil composition, sensitivity to soil density, and poor calibration technique. Several approaches are described and evaluated for minimizing these sources of error. Included among these approaches are: mathematical analyses of the nuclear gauging principles, the calibration model method, and the dual-gauge principle for nuclear density gauges. (auth)

39377 (PRNC–135, pp 327-49) DIGITAL TELE-METERING BY GAMMA ATTENUATION OF THE LEVEL AND DENSITY OF LIQUIDS STORED IN TANKS. Castagnet, Antonio C.; Lorenzetti, Jose R.; Gillen, Ricardo (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). (In Spanish).

From Radiation and isotope technology in Latin American development.

The CNEA has designed and is building a telemetry system for the joint or individual reading of the level, mean density and weight of liquids stored in large tanks, such as those used in the petroleum, gas and petrochemical industries. For all measurements the equipment uses a single movable probe based on gamma ray attenuation, which as it explores a liquid column of constant thickness makes it possible to obtain readings without physical contact with the stored liquid. This report describes the principles of how this system functions, the basis of its design and the components of the system now under construction. (auth)

39378 (PRNC–135, pp 483-94) IN SITU MEASUREMENT OF THE DENSITY OF SEA FLOOR SEDIMENT BY GAMMA RAY TRANSMISSION. Preiss, K. (Negev Inst. for Arid Zone Research, Beersheba (Israel)).

From Radiation and isotope technology in Latin American development.

Apparatus which measures the density of the sediment on the sea floor by the principle of gamma ray transmission is described. It consists of a two-legged probe, held on a tower. The tower is lowered on the sea floor at the end of an electrically conducting armored cable. To obtain a density measurement a motor on the tower is actuated and the probe pushed into the soft sediment,

while the pulses due to detected gamma radiation are sent up the armored cable to a scaler-timer aboard the ship. The design, calibration and use of the probe are described. (auth)

39379 CALIBRATION METHOD FOR ^{55}Fe X-RAY SULFUR GAUGES WITHOUT SULFUR STANDARDS. Fries, B. A. (Chevron Research Co., Richmond, Calif.). Anal. Chem.; 42: 999-1001(Aug 1970).

The essential monochromatic x radiation from a ^{55}Fe source permits simplification of the calibration. Only the product of the mass absorption coefficient of carbon and the sample path length is determined experimentally using pure hydrocarbons. The coefficients for sulfur and hydrogen are eliminated by substituting their values relative to carbon, obtained from the literature, into the equation relating the count rate and the sample composition. The density and hydrogen content of the sulfur-containing sample must be known. The calibration agrees to about 2% with that obtained from sulfur standards. In practice, only three hydrocarbons are required for a calibration. (auth)

39380 QUANTITATIVE EVALUATION OF ORE MINERALIZATION IN DRILL HOLES BY GAMMA-GAMMA LOGGING. Simon, L. (Mining Inst., Prague). Can. Mining J.; 90: 57-9(Jul 1969).

Gamma-gamma logging is now being used in Czechoslovakia for logging large-diameter vertical drill-holes from the surface (bench holes), to a lesser extent for logging small-diameter bench holes from the surface, ranging from 54 mm upwards, and also for logging large- and small-diameter holes drilled into the floor of mine workings. The existing series-produced logging instruments, however, are not especially modified for small-diameter bores of arbitrary dips drilled directly from the mine working, including uppers. Therefore, the well-known method of gamma-gamma logging was modified in the Mining Institute in Prague for logging narrow-profile holes, drilled directly from the mine working up to a length of 200 meters at arbitrary dips. For this purpose a reliable detector and logging probe was also developed and operationally tested on various types of ore deposits, especially in situ in Czechoslovakia tin mines. The operational results were verified by laboratory investigations of models. (auth)

39381 MEASURING APPARATUS AND METHOD. Locke, Stanley (to Schlumberger Technology Corp.). U. S. Patent 3,509,343. 28 Apr 1970. Filed 21 Aug 1967.

A 14 MeV. neutron source and a 5 MeV. neutron source are mounted within a borehole logging tool. The neutron population characterizing the earth formation generated by the 14 MeV. source is contrasted with the neutron population generated by the 5 MeV. source by computing a ratio of the detected neutron activity originating in the higher energy range to the neutron activity produced by the low energy source. The ratio indicates the mineral composition of the earth formation surrounding the borehole. Thus, sandstone is characterized by a lower ratio than either a dolomite or a limestone formation, the silicon in the sandstone absorbing relatively more high energy neutrons. (auth)

39382 COMBINATION SIDEWALL NEUTRON POROSITY AND SONIC TOOL. Alger, Robert P. (to Schlumberger Technology Corp.). U. S. Patent 3,508,439. 28 Apr 1970. Filed 9 Dec 1966.

A technique for measuring the porosity, matrix composition or gas saturation of an earth formation surrounding a borehole is provided. The porosity may be determined by combining porosity-dependent signals derived from epithermal neutron radiation with the sonic transmission characteristics of the formation. The combined signals produce more accurate indication of formation porosity and also provide an indication of matrix lithology or gas saturation. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 39039, 39057, 39152, 39167, 39207, 39599, 39630, 39824, 40934, and 41007.

39383 (AECL-3559) THE INFLUENCE OF A TRAVELLING R.F. WAVE ON THE CROSSED-FIELD MOTION OF AN ELECTRON. Selander, W. N. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Feb 1970. 40p. Dep. CFSTI (U. S. Sales Only). AECL $1.00.

Consideration of the rotational motion of an electron in crossed electric and magnetic fields suggests that it may be subject to resonance with the Doppler frequency at which the electron encounters a traveling space harmonic wave. Although the general equations of the electron motion are nonlinear and cannot be solved explicitly, results obtained for two linearized versions of the equations support this view. Calculations in two limiting approximations show that the subharmonic resonance of order two is likely to disrupt smooth electron trajectories, and that "harmonic" resonances may occur but are expected to have less effect on the electron motion. These results are of interest for considerations of efficiency and stability in crossed field devices. (auth)

39384 (CEA-R-3971) A 100-MHz CODING SCALER. Goursky, Vsevolod; de Khovrine, Edith (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1970. 21p. (In French). Dep. CFSTI (U. S. Sales Only).

A description is given of a 12 bits coding scaler working at a clock frequency of 100 MHz, to be used in conjunction with a WILKINSON amplitude-to-time converter. In the design, special attention is given on two points: the phasing circuit to trigger the start-pulse by means of the first flip-flops of the binary scaler which acts as fast discriminator, and a straighforward circuit in order to eliminate cyclic defects in differential linearity due to transitions of the flip-flops. (auth)

39385 (DP-Report-232) THERMOCOUPLE CONNECTOR LIFE TEST. PART I. Project DRAGON. Willshire, S. J.; Hollick, R. C. (Atomic Energy Establishment, Winfrith (England)). Oct 1963. 22p. Dep. CFSTI.

Thermocouple connector systems have been investigated for use between the fuel element shroud ring and bedplate spike housing in the reactor pressure vessel. Short term life testing has been carried out on two different contact assemblies and a 3,000 hour life test on a design as described in D.P. Report 34, Section 10.6.7.2 and D.P. Report 75, Section 10.4.4. Experiments have also been carried out on the passage of direct currents in the order of 20 amperes through connectors although the contacts were originally designed without requirements of this nature in mind. Life testing of thermocouple connector assemblies will continue until such time that all modifications to the design have satisfactorily completed a suitable test period. Results on the present life test run and a "near future" run using $^{1}/_{16}$" diameter thermocouple cables with ceramic spacing insulators on the lead-out wires will be the subject of a further report. (auth)

39386 (DP-Report-285) THE PROPERTIES OF A VERTICAL HERSCH CELL. Project DRAGON. Capp, P. D.; Gray, P. S.; Symons, W. J. (Atomic Energy Establishment, Winfrith (England)). Jun 1964. 24p. Dep. CFSTI.

The properties of a sensitive Hersch cell are described and the variation of electrical output and rapidity of response are measured over a wide range of flows, external circuit resistances, and oxygen concentrations. A maximum sensitivity of 40 μA/vpm is achieved at oxygen concentrations below 5 vpm with an external circuit resistance of 100 ohms and a carrier gas flow of 400 ml/min N.T.P. The ultimate detection level is of the order of 0.1 vpm, i.e., 4 μA against a constant background of 5 μA. Further improvements in sensitivity are expected when the pressurized version of this cell becomes available. (auth)

39387 (EUR-4476) DATAT-DATA1-DATA2-CORFL: A COMPUTER PROGRAM FOR THE OFF-LINE DATA REDUCTION OF THERMIONIC MASS SPECTRA FOR ISOTOPIC ANALYSIS, RECORDED ON PAPER TAPE BY MEANS OF A DATAPRINT DIGITAL VOLTMETER. Tasman, H. A. (European Atomic Energy Community, Karlsruhe (West Germany). European Transuranium Inst.). 8 Jan 1970. 28p. Dep. CFSTI (U. S. Sales Only).

A flowchart and a detailed description of the program is presented. The program is in FORTRAN and ASSEMBLER for the IBM-1130. (W.H.K.)

39388 (INSJ-118) ON-LINE DATA TAKING PROGRAM FOR PDP-8 COMPUTER AND DEC TAPE. Iwata, Seigi; Imanishi, Akira (Tokyo Univ. (Japan). Inst. for Nuclear Study). 1 Jun 1970. 36p. Dep. CFSTI (U. S. Sales Only).

A program which takes counter data on line with the PDP-8 computer equipped with DEC tapes is described. The data are transferred to a 3-cycle data break facility from a logic interface to a computer memory. As a preliminary analysis during the data taking, they are processed to obtain eight kinds of pulse height distributions for particular events satisfying selected coincidence logics. Every 208 events are transferred to a DEC tape for a permanent storage. This program provides an example that controls the data acquisition and transfer. The complete listing of the program is presented. (auth) (Japan)

39389 (INSJ-119) OFF-LINE PROCESSING PROGRAM FOR MULTIPARAMETER SPECTRA DATA STORED IN DEC TAPE.

Iwata, Seigi (Tokyo Univ. (Japan). Inst. for Nuclear Study). 1 Jun 1970. 30p. Dep. CFSTI (U. S. Sales Only).

A program for the off-line analysis of multiparameter spectra data stored into a DEC tape is described. The analysis is done by the PDP-8 computer. A two-dimensional correlation between any pair of pulse heights for desired events can be obtained. In addition, they are further discriminated by a requirement on the other pulse heights. Two different pulse-height scales are available. The program is written by Program Assembly Language, and its complete listing is presented. (auth) (Japan)

39390 (RD/B/N-1581) TAP AND SCRAP: PROGRAMS FOR PROCESSING DATA FROM AUTOMATIC GAS ANALYSIS EQUIPMENT USING A PDP8/I COMPUTER. Russell, R. D.; Skinner, R. F. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb 1970. 56p. Dep. CFSTI (U. S. Sales Only).

The PAL III symbolic assembler programs TAP and SCRAP provide rapid processing of data, on a PDP8/I computer, from automatic gas analysis equipment used to measure gas composition changes in gas–graphite reactions. Assessment of the data, for correct operation of the equipment, is made using TAP while SCRAP converts selected data into working units and presents this information in a tabulated form. (auth) (UK)

39391 MINI-MAGNET. Bowman, J. D.; Henrikson, H. E.; Zawislak, F. (California Inst. of Tech., Pasadena). Nucl. Instrum. Methods; 84: 77-8(1970).

A small cylindrically symmetric electromagnet is described that saturates a 5.5 mm diameter ferromagnetic and sample with very small fringing field and small absorption scattering of gamma rays. (auth)

39392 CURRENT DEVELOPMENTS IN HIGH VOLTAGE ELECTRON MICROSCOPY. Reports on the First National Conference Held in Monroeville, Pennsylvania 17–19 June 1969. Fisher, R. M. Micron; 1: 220-307(Dec 1969). (CONF-690643).

For each of the twelve sessions held, a short summary of the subject under review is given together with the title, author and abstract of the papers presented. Separate abstracts have been prepared for the sessions on Radiation Damage and on Electron Accelerators for high voltage electron microscopes. (UK)

For abstracts of individual sections see: 39727 and 40528.

39393 TESTING FOR INCIPIENT FAILURE OF RELAYS IN REACTOR CIRCUITS. Perreault, John (General Electric Co., San Jose, Calif.); Ruby, Lawrence. Nucl. Appl. Technol.; 9: 402-7(Sep 1970).

A test has been devised to detect incipient failure of relays, which does not require removal of the relay from its circuit, nor does it require any system outage time in vital reactor applications. The relay parameter which is evaluated is the actuation time. The distribution of actuation times has been measured for several relays, of two different types. The distribution has been shown to shift as a function of coil voltage, overall temperature, and spring tension. A large shift in the distribution was noted as a result of a destructive heating test. As a result, the use of the 90% spread points of a reference distribution is proposed as a criterion for the detection of incipient failure in a periodic multiple-test program. (auth)

39394 1969 NUCLEAR SCIENCE SYMPOSIUM AND NUCLEAR POWER SYSTEMS ENGINEERING SYMPOSIUM, OCTOBER 29–31, 1969, SAN FRANCISCO, CALIFORNIA. PART I. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 1-615 (Feb 1970). (CONF-691017-(Pt.1)).

Separate abstracts were prepared for the 86 papers presented. Topics include radiation detector development for nuclear science, space applications, biomedical applications, geophysical applications, and oceanographic applications. Also, papers are presented on instrumentation, data acquisition systems for nuclear physics, interfacing of data acquisition systems to computers, reactor instrumentation, and nuclear power systems engineering. (W.H.K.)

For abstracts of individual papers see: 38740, 38762, 38799, 39045, 39089, 39239–39270, 39325–39337, 39356–39358, 39395–39406, 39584, 40536, 40537, 40727, 40728, 40905, 40934–40943, 41025, 41055–41057, and 41066.

39395 LOW-POWER MEMORY SYSTEM FOR PULSE-HEIGHT-ANALYZER SYSTEMS. Harrington, T. M.; Marshall, J. H. (Analog Technology Corp., Pasadena, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 102-9(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

This paper describes the design techniques used in producing two magnetic-core memories for space-flight applications. The design stresses low power, dense packaging and wide operating temperature range. Data showing secure operation for temperatures between –50°C and +80°C are presented. Typical power consumption exclusive of programming logic for a 1024 × 8-bit core array is 57 mW plus 9.8 μJ per read-write cycle and for a 4096 × 10-bit array is 72 mW plus 12.8 μJ per cycle. The 4096 × 10-bit array has been assembled as a dual-cycle 2048 × 20-bit memory and packaged using soldered cordwood modules. The time required for a single read-add-one-write cycle is 4 μs. (auth)

39396 SYSTEM FOR RETRIEVING AND PROCESSING DATA FROM BALLOONS AT HIGH ALTITUDES. Baldry, R. H. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 177-83(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A system was developed to transfer digital nuclear data and position control data from a high altitude balloon to earth for experiment control and monitoring purposes. The system was designed to be operated and maintained by personnel without access to, or familiarity with more complex military-aerospace telemetry data systems. Low cost, accessibility to the equipment and versatility are emphasized. Simple interfaces connect varied data sources and monitoring instruments to standard transfer units on the balloon and on the ground. A multiplexer-interface was designed to transfer data, recorded during a balloon flight, from a magnetic tape to a small computer which produces an IBM-compatible tape suitable for analysis by a large computer. (auth)

39397 PULSE SHAPING FOR NUCLEAR PULSE AMPLIFIERS. Nowlin, C. H. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 226-41(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The emphasis of this paper, in which a systematic approach to nuclear pulse shaping is presented, is on the power, versatility, and practicability of lumped-element transfer functions and their associated networks. The approach consists of first determining a suitable theoretical, but realizable, lumped-element transfer function for the problem at hand—pulse height analysis is the example used in this paper—and of then synthesizing this transfer function in a way that minimizes the sensitivity of the final output-pulse shape to network element variations. Finally, the network is built and tested using elements having tolerances determined by a sensitivity analysis of the chosen circuits. The unipolar transfer functions and networks discussed have better signal-to-noise ratios than any other published lumped-element transfer functions or networks. One unipolar pulse function has a signal-to-noise ratio that is only 0.5% worse than that of the delay-line-produced triangular pulse. Since the bipolar pulses discussed are more symmetrical about the base line than those of any other published lumped-element network, spectral peaks at high count rates obtained with these networks will be more symmetrical than those obtained with any other lumped-element network. Furthermore, these symmetrical pulses will produce smaller count-rate-dependent base-line shifts than will less-symmetrical equal-area pulses. Although the networks that are discussed in this paper are extremely useful for pulse height analysis, the systematic approach that is presented is more important because of its obvious extensions to other pulse shaping problems in nuclear physics. (auth)

39398 DECONVOLUTION AND COMPENSATION IN THE MEASUREMENT OF BROADBAND SIGNALS. Algazi, V. R. (Univ. of California, Davis); Ekstrom, M. P. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 291-8 (Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

This paper considers the recovery of broad-band non-random signals distorted by the dynamics of the transmission system and corrupted by additive noise. The design and performance of deconvolution and compensation systems for a mean-square performance measure are discussed. After pointing out the deficiencies of deconvolution without compensation, the joint design of the two signal processing schemes under engineering constraints is presented and illustrated by some examples. Finally the results obtained when the signals are samples of stationary random processes with known statistics are briefly discussed. (auth)

39399 LINEAR SEVEN-DECADE CURRENT/VOLTAGE-TO-FREQUENCY CONVERTER. Shapiro, Edward G. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 335-44(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A current-to-frequency converter was developed for low level current measurements of wide dynamic range. It measures currents from 5×10^{-13} to 6×10^{-5} amperes without range switching and by the use of state-of-the-art circuit components. It has a corresponding linear seven-decade transfer characteristic of 10^{-11} amperes per Hertz with a maximum output frequency of greater than 5×10^{6} Hz. The converter was designed to monitor photomultiplier tube current in an automated thermoluminescent dosimetry (TLD) system. (auth)

39400 TIME-SHARING A DISK MEMORY FOR ON-LINE SPECTRUM ACCUMULATION FROM MANY NUCLEAR PULSE-HEIGHT ANALYZERS. Uber, Donald C. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 390-7(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Several pulse-height analyzers time-share a large disk memory for on-line accumulation of sorted spectra. The system is controlled by a PDP-8 computer which performs a two-level hardware-software sort on the data in real time. The computer dynamically allocates storage to incoming events and schedules disk accesses to achieve high sorting rates under a variety of counting loads. (auth)

39401 BONER-II AN ON-LINE MULTI-LABORATORY DATA ACQUISITION SYSTEM. Jones, Hugh V. Jr. (Rice Univ., Houston, Tex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 398-404(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

BONER-II, a revision of BONER, a programmed on-line multi-laboratory data acquisition system implemented on Bonner Nuclear Laboratories' IBM 1800 Computer, supported by IBM's Time-Sharing Executive (TSX), and interfaced with Bonner Laboratories' Experiment Control Unit (ECU), incorporates the following: (1) independent concurrent acquisition and analysis of data from a maximum of eight laboratories; (2) dynamic real-time storage allocation of data input/output buffer blocks, processed or unprocessed data analysis buffer blocks, and program blocks; (3) garbage collection and relocation of core blocks to optimize usage of core; (4) dynamic allocation and release of peripheral equipment to accommodate the varying needs of the various laboratories; (5) selective program-controlled display of data analysis buffers; (6) queueing of non-process function programs to operate on displayed data analysis buffers; (7) partial or total real-time data analyses (the percentage of which can be varied by the experimenter); (8) non-process time-sharing of program compilation and debugging, or data analyses as coordinated by TSX when BONER-II is not in control. This paper discusses the software implementation of BONER-II to a multi-laboratory environment for the purpose of maximizing usage of computer resources while minimizing the experimenter's need to interact with the computer data acquisition system. (auth)

39402 BELL-RUTGERS DATA HIGHWAY SYSTEM. Gere, E. A. (Bell Telephone Labs., Murray Hill, N. J.); Lie, H. P.; Miller, G. L.; Senator, A. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 436-44(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The Bell-Rutgers data highway system is a modular, general purpose system designed to provide a framework in which the configuration and reconfiguration of on-line computer hardware is easily accomplished. It is built using modified NIM hardware, and features a 16 bit parallel data path for input and output which is shared by up to 150 general purpose modules. Special consideration has been given to two particular problems; the operation of modules in an environment in which digital switching noise must be minimized, and the simultaneous use of the module system by several independent users. The initial application of the system has been in the implementation of a computer based nuclear physics data acquisition and analysis system. Some of the ways in which the system has been used are described. (auth)

39403 PHILOSOPHICAL AND PRACTICAL STANDARDIZATION OF COMPUTER INPUT/OUTPUT CONNECTIONS. Meng, John D. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 458-62(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Philosophically, small computer input/output connections can be made to a standard (such as CAMAC), rather than directly to a particular computer. Where manufacturer-produced software is either non-existent or can be sacrificed without heavy losses, a bigger computer may be practical with money saved from in-house interfacing. Such in-house peripheral interfacing can be made even more economical by practicing interface standardization. An example is discussed with solutions to the major problems involved. (auth)

39404 DATA TRANSFERS AND DEMAND HANDLING IN MULTICRATE CAMAC SYSTEMS. Barnes, R. C. M.; Hooton, I. N.; Richards, J. M. (Atomic Energy Research Establishment, Harwell, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 463-6(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The CAMAC modular instrumentation scheme provides a standardised means of data transfer between plug-in units within the same crate (data-bin). An extension of the scheme permits multi-crate systems to make use of a standard interconnection which incorporates flexible demand handling and automatic adjustment of the transfer timing. With the exception of the computer interface all components of a system are then computer independent and interchangeable. (auth)

39405 MODULAR, DIGITAL INTERFACE SYSTEM UTILIZING A BUS STRUCTURE. LaSalle, R. A. (Florida State Univ., Tallahassee). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 467-75(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A modular bus oriented digital interface system has been designed and is being implemented for on-line data acquisition in low energy nuclear physics and related experiments. The structure of the system is similar in many ways to that of CAMAC, but differs specifically in that modular construction is simplified for rapid single unit fabrication and debug. The system will be used in conjunction with an EMR 6130 and an SDS 9300 digital computer. (auth)

39406 SYSTEMS DESIGN FOR DATA ACQUISITION AND CONTROL. Aschenbrenner, R. A.; Vonderohe, R. H. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 476-80(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

In the design of systems for data acquisition and control, the hardware and software tradeoff is governed by a number of interrelated factors. The availability and capability of hardware, the effective decrease in hardware costs with similar increases of software costs force quantitative decisions on the determination of the system parameters that effect the design efficiency. This paper discusses many of the system characteristics abstracted from several computer aided experiments which may be used as a guide in design. (auth)

39407 IMAGE INTENSIFICATION TECHNIQUES APPLIED TO THE STUDY OF X-RAY DIFFRACTION PATTERNS. Reynolds, Geo. T. (Princeton Univ., N. J.). Contract AT(30-1)-3406. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 310-17(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

The usefulness of image intensifiers in the study of X-ray diffraction patterns can be obtained with a marked economy of X-ray exposure compared with conventional film recording or sequential diffractometer techniques, making possible the study of materials very susceptible to radiation damage and systems exhibiting dynamic characteristics which limit permissible dosage or exposure times. In addition, the reduction of time required for the recording of a pattern permits studies of families of crystals with large unit cell size containing many diffraction spots. Various X-ray sensitive cathode arrangements are described and compared. Image intensifiers and read-out techniques available are discussed. Results have been obtained for certain organic crystals demonstrating the capabilities of a system that has reduced the time required for certain exposures by a factor of several hundred. (auth)

39408 TELEVISION SYSTEM FOR THE DIRECT ANALYSIS OF X-RAY DIFFRACTION PATTERNS. Arndt, U. W.; Gilmore, D. J. (MRC Lab. of Molecular Biology, Cambridge, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 318-22(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Further progress has been made with a direct recording system of X-ray diffraction patterns from single crystals. In this system the pattern is formed on a phosphor screen and viewed by a T.V. camera tube whose video output is digitised and presented to a computer. Earlier work had shown that with a sufficiently high degree of light amplification between the phosphor and the T.V. camera, individual 8 keV quantum scintillations could be detected and moderately weak patterns could be dis-

played on a T.V. monitor. However, for quantitative work on weak patterns the limit is set by the quantum noise due to the low X-ray flux; consequently, in the present system the camera tube, which is now an Image Isocon, is operated in an integrating mode. After each 'exposure', during which the reading beam is switched off, the integrated charge pattern on the target of the Isocon is read out in a strobing fashion: the target is scanned at normal speeds but the beam is switched on only at those points where diffraction spots are known to be situated. The charge image of a diffraction spot is neutralized when the spot has been scanned, i.e., the read-out from the camera is destructive. It has been found that, owing to slight crystal misorientation and to aberrations in the light- and electron-optical systems, the positions of the diffraction spots can only be predicted approximately from the lattice spacings and initial orientation of the crystal: a computer-controlled search for the spot is, therefore, necessary. This type of search, or refinement, is possible only with a non-destructive read-out. Our final system will, therefore, incorporate an analog disc system acting as a buffer store on which one television frame can be stored for analysis. Only part of the system has been tested. It has been shown that the standard Isocon is capable of integrating and storing a pattern without loss of resolution for several minutes, provided it is cooled to ca −10°C. (auth)

39409 SOURCES OF MULTI-ELECTRON EMISSION IN VERY LOW DARK CURRENT IMAGE INTENSIFIERS. Randall, R. P. (EMI Electronics Ltd., Middlesex, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 323–8 (Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-70001.

High gain, multi-stage cascade image intensifiers with Sb (KNa) bi-alkali input photocathodes exhibit exceptionally low dark current. Because of the imaging properties of these tubes, the spatial distribution of dark current events, especially those involving instantaneous multielectron emission, can be investigated to yield information on the causes of dark current sources which are not related to the thermal conditions of the photocathode. (auth)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 40172 and 40484.

39410 (BNWL–1365) EFFECTS OF FAST NEUTRON IRRADIATION ON THE PERFORMANCE CHARACTERISTICS OF REACTOR-GRADE THERMOCOUPLES. Hoitink, N. C.; Weddle, R. C.; Thompson, D. C. (Battelle-Northwest, Richland Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45–1)–1830. 42p. Dep. CFSTI.

Irradiation of 55 Chromel/Alumel thermocouples in the EBR-II reactor to a total fast neutron fluence of about 7×10^{21} nvt and subsequent testing provided significant information regarding anticipated performance of such sensors in a fast flux reactor environment. The tested 0.0625-in. diameter, stainless steel sheathed, MgO insulated sensors included both insulated and grounded junction construction. Tests performed before and after irradiation included wire resistance and insulation measurements, emf versus temperature calibration, and time response determination. Test results revealed negligible change in wire resistance and characteristic time constant values; decreases of up to 10^4 ohms in insulation resistance (due in part to seal failure); and changes in emf versus temperature calibration of up to about 1%. (auth)

39411 (CEA-Bib-166) REVIEW OF BEHAVIOR OF TRANSISTORS AND INTEGRATED CIRCUITS UNDER IRRADIATION. Decuyper, Jean-Claude (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar 1970. 42p. (In French). Dep. CFSTI (U. S. Sales Only).

Radiation effects on the realiability of electronic systems are reviewed. Radiation effects on semiconductor materials, semiconductor devices, and integrated circuits are discussed. A list of 66 references is included. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 39407 and 39408.

39412 (NIRS–8) ANNUAL REPORT, 1968–1969. (National Inst. of Radiological Sciences, Chiba (Japan)). Oct 1969. 85p. Dep. CFSTI (U. S. Sales Only).

Separate abstracts were prepared for the four sections of this report. Lists of staff members and of publications during the report year are included in an appendix. (E.R.B.)

For abstracts of individual sections see: 39220, 39419, 39428, and 39456.

Basic Processes

Refer also to abstracts 39307 and 39538.

39413 (CU–3835–2) TRITIATION OF PROTEIN HORMONES. Progress Report, 1969–1970. [Lieberman, Seymour; Zimmering, Paula E.; Hembree, Wylie C.] (Columbia Univ., New York. Coll. of Physicians and Surgeons). [4 Mar 1970]. 13p. Dep. CFSTI.

In collaboration with the Dept. of Chemistry at the Brookhaven National Laboratories, a new method has been developed by which a variety of tritium-labeled compounds has been prepared. Of primary interest in isotope labeling methodology, is the ability to obtain tritium-labeled polypeptides and proteins, and the results indicate that the current approach will be successful. Since most classes of organic compounds are labeled by this technique, a systematic examination of the mechanism of tritium-hydrogen exchange, the understanding of which will provide an essential basis for future peptide labeling was begun. The unique feature of the experimental design is the ability to study the interaction of activated tritium with an organic substrate as an isolated chemical event. Complex primary external radiation effects are virtually eliminated by short exposure time to tritium and the effects of high temperature, short wavelength uv light, and the ionizing conditions of high electron flow are eliminated by use of an internal pump to cycle the tritium. The results to date with ACTH indicate that a polypeptide of moderate complexity can be labeled with significant loss of biologic activity. From the studies with oligopeptides now in progress, it will be possible to define precisely the chemistry of peptide labeling and the analytical requirements for radiochemical purification. With this information available, the extension of tritium labeling to the investigation of polypeptide and protein hormones in general will then be possible. (auth)

39414 (NP–18300) APPLICATION OF RADIO-ISOTOPIC PROCEDURES TO THE PHYSIOLOGY OF STEROID HORMONES IN BLOOD WITH PARTICULAR REFERENCE TO ALDOSTERONE. Scoggins, Bruce A. (Melbourne Univ., Parkville (Australia). Howard Florey Labs. of Experimental Physiology). 1968. 284p. Thesis.

A double isotope derivative dilution procedure was developed to enable the concentration of aldosterone to be determined in peripheral blood of man (5.8 ng/100 ml). 4-^{14}C-aldosterone (s.a. 56 mCi/mM) was used as the recovery indicator and ^{3}H-acetic anhydride (s.a. 500 mCi/mM) to form the radioactive derivative. Purification of the radioactive derivative was obtained by paper partition chromatography and further derivative formation. Specificity was evaluated by analysis of steroid-free samples (non-specific blank 0.22 ng/sample) and by multiple derivative formation. Accuracy and precision were assessed by recovery of a known aldosterone standard added to adrenalectomized plasma and by replicate measurement at four levels respectively. This analytical procedure was further modified to enable simultaneous estimation of both concentration and the amount of ring labelled ^{3}H-steroid in a sample. This latter technique was applied to studies on the in vivo biosynthesis of aldosterone and steroid dynamic studies on aldosterone and cortisol in the sheep. A detailed evaluation of the statistical counting errors arising from liquid scintillation counting of double labelled samples at the count rates found in actual samples was made and the effect of sample mass, counting efficiency, counting time, and non-specific blank determined. The procedure for measurement of aldosterone in peripheral blood was used in physiological studies on control of aldosterone in the sheep and in a number of clinical situations in man. (Australia)

39415 (PRNC–135, pp 233–8) RADIOIODINE ABSORPTION AND CONVERSION FORMULA BY THE THYROID IN PATIENTS WITH PULMONARY TUBERCULOSIS DURING TREATMENT. Patetta Queirolo, M. A.; Fernandez Ordonez, A. (Carabobo Univ., Valencia (Venezuela). Facultad de Medicina). (In Spanish).

From Radiation and isotope technology in Latin American development.

Thirty-nine men and twenty-one women with pulmonary tuberculosis were studied during treatment with streptomycin + isoniacid, PAS + isoniacid, and streptomycin + PAS + isoniacid. The twenty-four hour ^{131}I thyroid uptake (men) and the same uptake, rate conversion, and basal metabolic rate (women) were determined. Men treated with streptomycin + isoniacid showed high values of uptake within five to eight months, while men treated with PAS + isoniacid showed high values in thyroid uptake within eight months of treatment. Women treated with PAS + isoniacid showed high values in ^{131}I uptake and conversion ratio in 57.2% of all patients similar to those observed in hyperthyroidism, with elevation in basal metabolic rate. This fact is emphasized, suggesting the study of thyroid function in patients with pulmonary tuberculosis before and during treatment. (auth)

39416 (STI/DOC–10/111) ISOTOPE TECHNIQUES FOR STUDYING ANIMAL PROTEIN PRODUCTION FROM NON-PROTEIN NITROGEN. Report of a Consultants' Group held in Vienna, 25–28 August 1969. Technical Reports Series No. 111. (International Atomic Energy Agency, Vienna (Austria)). 1970. 31p. IAEA $2.00.

There is a definable role for non-protein nitrogen (NPN) in the feeding of ruminants. Non-protein nitrogen (NPN) can be used as an admixture in concentrate rations for milk and more intensive beef production. The economic feasibility of NPN application must be carefully evaluated, particularly in countries where the relatively expensive quick energy releasing materials would have to be introduced into ruminant feeding. Some developing countries have a relative abundance of by-products rich in protein, and NPN generally could not be recommended under such conditions. Research methods appropriate for evaluation of NPN sources are outlined. Three isotopes were pointed out as being especially useful and the application of each can be summarized as follows: ^{15}N for rate of NH_3 production in rumen, rate of incorporation of N compounds into microbial protein, and overall conversion of NPN to tissue or milk protein; ^{14}C for rate of hydrolysis of C-containing NPN, turn-over and entry rate of amino acids, and estimates of protein synthesis; ^{35}S for estimates of microbial protein synthesis and of microbial contribution to synthesis of milk, wool, muscle. (auth)

39417 DETERMINATION OF POTASSIUM, SODIUM, AND MAGNESIUM CONTENT IN PLASMA FREE ERYTHROCYTE SEDIMENTS AND IN THE AVERAGE SINGLE ERYTHROCYTE BY MEANS OF A ^{51}Cr EDTA ISOTOPE DILUTION TECHNIQUE. Burck, Hans-Christian (Univ., Tuebingen, Ger.). Klin. Wochensch.; 48: 105–11 (15 Jan 1970). (In German).

A simple method was described for the determination of trapped plasma by ^{51}Cr-ETDA in red cell sediments. Analysis of this red cell sediment by flamephotometry allowed the determination of the real Na^+, K^+, and Mg^+ contents of erythrocytes per kilogram. Since red blood cell counts (RBC) may be registered out of the same sample of sediment, cation content per single red cell could be calculated. Comparative analysis of trapped plasma by ^{131}I-albumin and ^{131}I-inulin showed the ^{51}Cr-EDTA method to be superior. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 39302, 39456, 39531, 39536, 39548, 39549, 39582, and 39587.

39418 (AEC-tr–6944(Rev.)) DISTRIBUTION AND BIOLOGICAL EFFECTS OF RADIOACTIVE ISOTOPES. Moskalev, Yu. I. Translation of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966. 718p. Dep. CFSTI.

Separate abstracts for each of the 80 papers contained in this translation were previously published in NSA. To consult these abstracts refer to NSA Vol. 23, issue 12, abstracts numbered 22151 to 22183, 22247, 22248, 22250, 22270 to 22278, 22318 to 22321, 22362 to 22391, and 22439. The correction sheet found in the front of NSA Vol. 23, issue 19, referring to translating errors in some of these abstracts, should also be consulted. (E.R.B.)

39419 (NIRS-8, pp 53-61) MEDICAL STUDIES. (National Inst. of Radiological Sciences, Chiba (Japan)).

Brief papers or abstracts are presented for seven medical research projects being conducted at NIRS during fiscal 1968. The investigations include: ^{131}I-methyliodide metabolism in rats; ^{85}Sr and ^{47}Ca kinetics in patients with osteoporosis; clinical whole-body counting with a remodeled profile scanner; RBE of single and fractionated doses of fast neutrons to x rays for intestinal damage in mice; use of digital computers in teiecobalt treatment planning; hematopoietic stem cell recovery in x-irradiated mice; and persistence of chromosome aberrations in bone marrow of irradiated humans. (E.R.B.)

39420 (RLO-2093-2) RADIONUCLIDE CYCLING IN NATURAL POPULATIONS OF AMPHIBIANS. Annual Progress Report, June 16, 1969-June 15, 1970. Willis, David L. (Oregon State Univ., Corvallis). Contract AT(45-1)-2093. 3p. Dep. CFSTI.

Research on the uptake, metabolism, distribution, and retention of radioisotopes by newts is discussed. Among the projects reported are: retention of ^{65}Zn by Notophthalmus viridescens at room temperature following injection; uptake and retention of ^{54}Mn, ^{60}Co, ^{65}Zn, ^{85}Sr, ^{86}Rb, ^{131}I, and ^{134}Cs in rough-skinned newts (Taricha granulosa); effects of temperature on ^{134}Cs metabolism in newts; time-course studies of ^{134}Cs distribution in organs and tissues of newts; metabolism of injected ^{54}Mn and ^{86}Rb in newts; uptake and metabolism of ^{60}Co, ^{65}Zn, ^{85}Sr, and ^{131}I in newts; and time-course studies of tritium uptake and retention in newts. The final project reported on was an investigation of the effects of radiation dose on the radiosensitivity of N. viridescens. (E.R.B.)

39421 EFFECT OF PROLACTIN ON ORGAN WEIGHTS AND ^{65}Zn UPTAKE IN MALE BABOONS. Schoonees, R. (Univ. of Stellenbosch, Bellville, S. Afr. Karl Bremer Hospital, Bellville, S. Afr.); de Klerk, J. N.; Murphy, G. P. J. Surg. Oncol.; 2: 103-6(1970).

Prolactin in the dosage schedule employed affects the metabolism of ^{65}Zn as indicated by a reduced uptake of this isotope by most tissues examined following the intravenous administration of $^{65}ZnCl_2$. In this study, however, no evidence was found of a direct effect of prolactin on the prostate in the intact adult male Chacma baboon. (auth)

39422 EFFECTS OF CARRIER ON THE RETENTION, EXCRETION, AND DISTRIBUTION OF ^{144}Ce IN THE RAT. Takada, Kazuo (Japan Atomic Energy Research Inst., Tokai); Fujita, Minoru; Suzuki, Masashi. J. Radiat. Res.; 11: No. 1, 24-31 (Mar 1970).

Cerium-144 was injected intravenously into rats as the chloride with different amounts of carrier. After a single injection the whole-body retention, daily fecal and urinary excretion, and tissue distribution were studied during about a month. The following results were obtained. Addition of carrier suppressed the early urinary excretion that was observed with carrier free ^{144}Ce. A large amount of carrier markedly suppressed the fecal excretion that was the main excretory route of cerium. In general, the maximum value of fecal excretion was observed about a few days after injection, although it depended on the carrier level, and the whole-body retention curves showed sigmoidal patterns. As the amounts of carrier increased, ^{144}Ce decreased in the bone and kidney, and increased in the liver and spleen. It seemed that, when the carrier level was low, intravenously injected ^{144}Ce showed relatively ionic nature but as the carrier increased it showed more colloidal nature. (auth)

39423 UPTAKE OF IRON INTO ERYTHROID CELL. Wise, William Curtis. Lexington, Ky.; Univ. of Kentucky (1967). 163p.

Thesis.

Iron-59 uptake in the rabbit reticulocyte was measured in the presence of 2,4-dinitrophenol, iodoacetic acid, cobalt, varying iron concentration, ouabain, puromycin, lead, and the absence of sodium and/or potassium ions. 2,4-Dinitrophenol and iodoacetic acid reduced uptake of ^{59}Fe in the rabbit reticulocyte. ^{59}Fe uptake was decreased in the presence of cobalt ions. Ouabain inhibited ^{59}Fe uptake by 20% but only after a delay of 60 min. Puromycin and/or lead did not inhibit uptake. Omission of sodium or the presence of potassium resulted in inhibition of uptake. Ouabain was only effective in the presence of sodium. Kinetic studies indicate that V_{max} is sodium independent, but K_m is greater without sodium than with sodium. ^{59}Fe uptake in the rabbit and cat erythrocyte and reticulocyte was measured in the presence and absence of glucose and their respective sera. Glucose did not affect uptake. Serum did not affect uptake in the reticulocyte, but uptake was greater in the erythrocyte without serum. Adenosine triphosphatase activities were determined. Greater stromal sodium-potassium-simulated adenosine triphosphatase activities were associated with greater ^{59}Fe in the cell hemolysate. These results indicate that uptake of ^{59}Fe in the erythroid cell is partially dependent on a sodium gradient, extracellular to intracellular, and a source of metabolic energy. There is also evidence that iron uptake is independent of protein synthesis and that the sodium-potassium-stimulated adenosine triphosphatase system plays some role in movement of iron into the erythroid cell. (Diss. Abstr.)

39424 IRON METABOLISM IN MYTILUS EDULIS. II. UPTAKE AND DISTRIBUTION OF RADIOACTIVE IRON. Hobden, D. J. (Univ. of Ottawa). J. Mar. Biol. Ass. U. K.; 49: 661-8 (Aug 1969).

The uptake and distribution of ^{59}Fe (added to seawater as ferric chloride) by mussels were studied. The concentration of radioisotope in the water varied from 0.01 to 0.1 μCi/ml. It was found that Mytilus absorbs soluble ^{59}Fe from citrated seawater either directly or via adsorption on the mucus used in feeding. The adsorption slows or ceases after 3 to 7 days when the total Fe uptake is about 1% of the total body content. In order of decreasing radioactivity, ^{59}Fe is absorbed into the byssus threads, renal organ, digestive gland, gut epithelia, gills, walls of heart and blood sinuses, and gonadial and muscular tissues. The ^{59}Fe persisted when the animals were transferred to clean sea water. The ^{59}Fe uptake could have occurred either directly into the blood stream across the gill or mantle epithelia, or by way of the normal feeding mechanism. The appearance of ^{59}Fe in the renal organ before it was detected in the digestive gland suggests that some of it entered across the gill epithelia. The general distribution of the radioactivity shows that ^{59}Fe did circulate around the body. The predominance of the digestive gland in the over-all uptake by the mussels was shown by the negative slope of the calculated regression lines. (BBB)

Radiation Effects

Refer also to abstracts 39450, 39563, 39575, 39577, 39586, 39589, and 39596.

39425 (AECL-3565) BIOLOGY AND HEALTH PHYSICS DIVISION PROGRESS REPORT, OCTOBER 1-DECEMBER 31, 1969. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 92p. (PR-B-84). Dep. CFSTI (U. S. Sales Only).

Research activities at the Biology and Health Physics Division of CRNL are reported for the third quarter of 1969. The 70 research projects that are reported on were conducted by the Biology Branch (24), Environmental Research Branch (21), and Health Physics Branch (25). The 24 biology projects, for which summaries or brief reports are presented, include investigations in the following areas: RNA molecules; radiation biochemistry; radiomimetic chemicals; repair of DNA in bacteria; and structure of nucleoprotein. The 21 environmental projects include biological and physical studies, meteorological studies, and chemical studies. The 25 health physics projects reported on include investigations on radiation detectors, radiation dosimeters, health instruments development, and results of routine monitoring. Lists are included of division staff members, papers published, and lectures presented by staff members during the reporting period. (E.R.B.)

39426 (AI-AEC-12974) RADIATION CHEMISTRY OF CHROMOSOMES. Final Report, July 1, 1969-June 27, 1970. Sevilla, M. D. (Atomics International, Canoga Park, Calif.). 27 Jun 1970. Contract AT(04-3)-701. 122p. Dep. CFSTI.

The effects of ionizing radiation on chromosomes and chromosome constituents were investigated. This work concentrated on the reactions of radical intermediates produced by ionizing radiation with chromosome constituents. Reactions of hydrogen atoms and electrons with these constituents were investigated previously. Studies of reactions of electrons with chromosome constituents were continued with an investigation of peptides, pyrimidines and nucleosides. The electrons were photolytically generated in an alkaline D_2O glass and allowed to react with the peptide solute; the radicals produced were identified by means of ESR spectroscopy. The reaction sequence for peptides is found to be similar to the amino acids in previous investigation. At 77°K electron attachment to dipeptides and tripeptides composed of glycine and amino acids with alkyl side groups produce the dianion radical. Upon warming, the dianion undergoes N-terminal deamination. The radical formed in this step subsequently abstracts from the parent compound to form an α carbon radical. The results for N-acetylamino acids and N-acetylpeptides show that the electron is localized in the peptide bond in dipeptides and in the N-terminal peptide bond in tripeptides. The localization at the N-terminal bond is suggested to be a result of

a deeper potential energy well at that bond. The anion radicals of the pyrimidines and nucleosides were produced by electron attachment. The use of a deuterated glass yielded resolved ESR spectra that were not observed in our previous work with these compounds; the spectra consist of a large doublet splitting, which is caused by a large unpaired electron density at the C_6 position. Significant differences in this splitting are found for the pyrimidine and nucleoside anions. Positive ions of chromosome constituents were investigated using positive ions of thymine and thymidine. The positive ion of thymine was produced at 77°K by photoionization in both acid and alkaline glasses; the ESR spectrum found for this species is in excellent agreement with that predicted by theory. Upon warming the sample to 130°K, the positive ion decays by loss of a methyl proton to form a $R\text{-}CH_2 \cdot$ radical. The thymidine positive ion is not found to be stable at 77°K. For thymidine the ESR spectra indicate that the $R\text{-}CH_2 \cdot$ radical is formed at 77°K. This work suggests that in the chromosome positive ions or holes formed in the DNA during radiolysis would localize unpaired spins on thymidine by production of $R\text{-}CH_2 \cdot$ radicals. A study of the radiolysis of frozen aqueous solutions of DNA suggests that the thymidine anions formed by electron attachment protonate at the C_6 position to form the usual thymyl radical. (auth)

39427 (COO-1313-24) EFFECTS OF GAMMA-IRRADIATION ON DNA TRANSCRIPTION AND RNA TRANSLATION IN PLANTS. Progress Report. Cherry, Joe H. (Purdue Univ., Lafayette, Ind. Dept. of Horticulture). 1969. 16p. Dep. CFSTI.

Research during the past year has involved the effects of x- and γ irradiation on RNA methylation, invertase production, and chromatin-directed RNA synthesis in sugar beet tuber tissue. The results of γ irradiation (100 and 200 kR) were the following: suppression of amino acid uptake by tissue slices; suppression of the incorporation of leucine into protein; impairment of chromatin-RNA polymerase activity by as much as 50%, whether the tissue was quiescent (non-washed), or in a rapidly metabolizing state (washed for 20 hr); and a decrease in the amount of available DNA template sites. Both x and γ irradiation caused enhancement of invertase activity correlated with increased methylation of transfer RNA. The last two observations are not yet understood, since the synthesis of both protein and RNA is impaired by ionizing radiation. It is not yet clear whether increased methylation of tRNA is causally related to increased invertase production, since γ irradiation-increased tRNA methylation, and invertase production is very tenuous. From the present results, it was concluded that ionizing radiation impairs RNA polymerase activity and inhibits the amount of DNA template transcription. This leads to a decreased rate of protein synthesis. (auth)

39428 (NIRS-8, pp 19-52) BIOLOGICAL STUDIES. (National Inst. of Radiological Sciences, Chiba (Japan)).

Biological investigations during the 1968 fiscal year at the National Institute of Radiological Sciences included research in the areas of biochemistry, biophysics, cytology, genetics, morphology, and physiology. Brief papers or abstracts of 36 specific research projects are presented. (E.R.B.)

39429 ANALYSIS OF DEFECTS IN THE MACROMOLECULAR ORGANIZATION OF DNA INDUCED BY IONIZING RADIATION. Ryabchenko, N. I.; Ivannik, B. P.; Tseitlin, P. I. (Inst. of Experimental Biology, Moscow. Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 10: 253-61(Mar-Apr 1970).

The size of the portion of DNA, the appearance of two single breaks in opposite strands leading to a decrease in the molecular weight of double-stranded DNA, was determined at various stages of the radiation degradation of DNA. An analysis of the experimental data indicated that at the initial stages of radiation degradation of DNA, the majority of the paired breaks were a result of breaking of two strands of DNA in one place. However, at large doses of irradiation, leading to the appearance of a rather large number of single breaks in DNA, the overwhelming majority of the paired breaks are a consequence of the statistical accumulation of single breaks in the DNA strands. (auth)

39430 EFFECTS OF ULTRAVIOLET RAYS ON MONOLAYER INTERFACES OF LIPOVITELLIN. Tongur, A. M.; Volkova, M. S.; Pavlovskaya, T. E. (Inst. of Biochemistry, Moscow). Radiobiologiya; 10: 283-8(Mar-Apr 1970).

It is shown that the denaturation of lipovitellin in a monolayer by exposure on a surface with high ionic strength leads to a significant increase in the area of the monolayer and linearization of the isotherm of compression. An analogous effect is observed in the preliminary denaturation of lipovitellin in solution by thermostatic control at 18°C. UV irradiation produces an increase in the stretching of the monolayer at the initial point of the condensed phase of 0.7 dyn. The dose dependence of the change in the permeability of a monolayer of lipovitellin is obtained. A dose of $1.2 \cdot 10^7$ erg/cm^2 entirely removes the barrier effect of the interface. It is hypothesized that the cause of the observed changes in the surface properties and permeability of lipoprotein monolayers is a disruption of the hydrophobic lipid-protein interaction in the lipovitellin molecule. (auth)

39431 CAUSES OF RADIATION ACTIVATION OF POLYPHENOL OXIDASE IN PLANTS. Korolev, N. P.; Kuzin, A. M.; Solob'ev, G. V. (Inst. of Biological Physics, Pushchino, USSR). Radiobiologiya; 10: 279-82(Mar-Apr 1970).

The dependence of the tyrosinase activity on the concentration of the substrate and the influence of hydroquinone and p-benzoquinone on the shape of the curve of this dependence, as well as the sedimentation of tyrosinase in the presence of hydroquinone, was studied. The data obtained were used to interpret the increase in the activity of polyphenol oxidase in plants after irradiation. (auth)

39432 RADIATION-INDUCED THYMINE FORMATION FROM THYMINE GLYCOL. Namiki, N.; Hayashi, T. (Nagoya Univ., Japan). Int. J. Radiat. Biol.; 17: 197-200(1970).

It has been shown that an interconversion between thymine and thymine glycol could be caused by γ irradiation in an oxygen-free aqueous system at room temperatures. The uv absorption spectra of 2mM thymine glycol solution (at pH 5.0) irradiated with 1 Mrad and diluted with 0.1 N HCl unirradiated thymine glycol and thymine were compared. Other investigations on the irradiation products were by thin-layer chromatography, microbial tests using B. subtilis T$^-$ and quantitative assay by gas chromatography after trimethylsilylation of the freeze-dried irradiation products. Thymine formation was almost suppressed by the presence of air or N_2O, but increased by $HCOO^-$ or CNS^-. The effect of N_2O, a scavenger for e^-_{aq}, suggested that the reverse reaction from thymine glycol to thymine is due principally to the action of e^-_{aq}. (UK)

39433 ELECTRON MICROSCOPY OF SINGLE-STRANDED DNA. Bujard, Hermann (Southwest Center for Advanced Studies, Dallas). J. Mol. Biol.; 49: 125-37(14 Apr 1970).

A method is described for the quantitative study of single-stranded DNA by electron microscopy. It permits the determination of the size of single-stranded DNA with sample standard deviations between 5 and 8%. Since 80 to 100% of the molecules in a given field are usually measurable, size distributions can also be obtained. The linear density of single-stranded DNA as seen on electron micrographs is determined and conditions which influence it are described. Thus direct measurement of molecular weights of single-stranded DNA is possible by this method. Furthermore, cross-linking of strands by uv irradiation is demonstrated, and an analysis of these data suggests that at 280 mμ, 1 erg mm^{-2} causes 2.3×10^{-6} single-strand breaks and 1.6×10^{-6} interstrand cross-links per 1×10^6 daltons of double-stranded DNA. The method appears to be especially useful for studying complexes in which double-stranded and single-stranded regions occur simultaneously. (auth)

39434 COMPLEMENTARY ACTION OF RECOMBINATION AND EXCISION IN THE REPAIR OF ULTRAVIOLET IRRADIATION DAMAGE TO DNA. Radman, Miroslav; Cordone, Lorenzo; Krsmanovic-Simic, Draga; Errera, Maurice (Univ. Libre, Brussels). J. Mol. Biol.; 49: 203-12(14 Apr 1970).

The roles of the bacterial rec and uvr genes and of the λ red functions for the survival of ultraviolet-irradiated λ phage were studied. If only a small number of pyrimidine dimers is present in the λ DNA, repair is preferentially performed by recombination (rec and red functions); excision repair (uvr functions) being efficient only for extensive damage. This is probably related to the ultraviolet-induced inhibition of DNA replication. A temporary inhibition of post-irradiation DNA replication was obtained using a λ, cistron O, thermosensitive mutant. It was thereby demonstrated that excision repair is efficient on non-replicating and recombination repair on replicating DNA. It is suggested that recombination and excision are complementary mechanisms for repairing ultraviolet irradiation damage to DNA, excision taking place before DNA replication and recombination repair after and/or during replication. Regulation of DNA replication is therefore an important factor for the efficient repair of DNA. (C.H.)

39435 TEMPERATURE DEPENDENCE OF UNSCHEDULED DNA SYNTHESIS IN HUMAN LYMPHOCYTES. Spiegler, P.; Norman, A. (Univ. of Southern California, Los Angeles). Radiat. Res.; 43: 187-95(Jul 1970).

Ultraviolet light (uv) and ionizing radiation stimulate two types

of unscheduled DNA synthesis in human lymphocytes: a fast process completed in about one hour after irradiation and a slow process which lasts for at least five hours. A study of the temperature dependence of unscheduled and of normal DNA synthesis shows that the rate for the fast process peaks between 42 and 44°C when stimulated by uv and near 42°C when stimulated by ionizing radiation. Normal DNA synthesis and DNA synthesis stimulated by phytohemagglutinin reach maximum rates between 37 and 40°C. Over the temperature interval 22 to 37°C, the range of the activation energy for the fast process is 18 to 25 kcal/mole when induced by uv, 16 to 18 kcal/mole when induced by ionizing radiation, and 21 to 24 kcal/mole for normal DNA synthesis. The upper limit for the activation energy of the slow process is 13 kcal/mole. (auth)

39436 DAMPENING OF DNA REPLICATION CYCLES AFTER X-IRRADIATION OR ULTRAVIOLET LIGHT IRRADIATION. Billen, Daniel; Bruns, Laura H. (Univ. of Florida, Gainesville). Biophys. J.; 10: 509-18(Jun 1970).

Escherichia coli strains 15T⁻ (555-7) and B/r were grown in the presence of thymine-^{14}C to label all DNA. The ability of these parental DNA's to undergo cycles of replication subsequent to cellular irradiation with either x ray or uv was followed with density labels. Exposed cells were shifted into the density medium at times which were approximately multiples of normal rounds of DNA replication. A portion of the parental DNA, replicated semiconservatively once during an initial cycle following uv or x irradiation in E. coli, failed to replicate again within the time studied. The time course of semiconservative parental DNA replication was altered. (auth)

39437 EFFECTS OF γ- IRRADIATION ON GLYCOLYSIS IN THE SEA URCHIN EGG. Asami, Kouichi (National Inst. of Radiological Sciences, Chiba, Japan); Yasumasu, Ikuo; Shoger, Ross L.; Fujiwara, Akiko. J. Radiat. Res.; 11: No. 1, 20-3 (Mar. 1970).

Unfertilized eggs of the sea urchin, Hemicentrotus pulcherrimus, were irradiated with ^{60}Co γ rays. Incorporation of ^{14}C-leucine into the protein fraction increased after 25 krads of irradiation. A slight acceleration of glycolysis by irradiation was indicated by the measurement of glycolytic intermediates both in unfertilized and fertilized eggs. However, the degree of activation of glycolysis with irradiation was much less than that following fertilization. However, the abnormal accumulation of fructose diphosphate after irradiation, which has been observed in tumor cells or thymocytes, was not observed in the eggs and was discussed in relation to cellular radiosensitivity. (auth)

39438 INDUCTION OF FATTY ACID SYNTHESIS IN CULTURED MAMMALIAN CELLS: EFFECTS OF CYCLOHEXIMIDE AND X-RAYS. Raff, R. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). J. Cell. Physiol.; 75: 341-51(Jun 1970).

It was found that L cells deprived of exogenous fatty acids responded adaptively by increased synthesis of fatty acids. This adaptive increase was found to be sensitive to cycloheximide presented at the time of removal of exogenous lipids, but was not sensitive to cycloheximide added six hours after removal of lipids. It was concluded that the adaptive increase in fatty acid synthesis represents a case of enzyme induction. The effect of x rays on this process was studied. It was found that induction was inhibited to a greater extent than total protein synthesis. Factors of potential importance to such an effect are discussed. (auth)

Immunology

Refer also to abstract 39517.

39439 (CONF-680634) SECOND INTERNATIONAL CONFERENCE ON GERMINAL CENTERS OF LYMPHATIC TISSUE, JUNE 26-28, 1968, PADOVA, ITALY. (Consiglio Nazionale Delle Ricerche, Rome (Italy). Oak Ridge National Lab., Tenn.). 54p. Dep. CFSTI.

Abstracts are presented of the 57 papers given at the conference. Twelve of these papers are within the scope of NSA. The titles of these 12 papers are: The relationship between development of the lymphoid system and susceptibility to irradiation and nitrogen mustard; Role of marginal zone cells of lymphoid follicles in the immune response of rabbits; Studies on the kinetics and radiation sensitivity of dendritic macrophages; The long-term proliferative capacity of cells from lymph nodes; Radiosensitivity of the antigen-trapping mechanism and its relation to the suppression of the immune response; The immunological specificity of ferritin uptake by macrophages in the rat; Kinetical studies on the induction of immune tolerance to protein antigen in sublethally x-irradiated rabbits; Alloantibody-forming cells detected by immunocytoadherence in skin-allografted mice; Chemical inhibition of blastic transformation in phytohemagglutinin-stimulated lymph nodes; Reactivation in vitro of antibody response in explants of x-irradiated spleens; Effect of red blood cell transfusion on the immune response of mouse radiation chimeras; and Immunological recovery of irradiated spleen by repopulation with circulating lymphocytes. An author index to the papers is included. (E.R.B.)

39440 (COO-1210-53) THE EFFECTS OF IRRADIATION ON ERYTHROCYTE CHIMERISM AND IMMUNOLOGIC TOLERANCE IN CATTLE TWINS. Annual Technical Progress Report VIII, March 15, 1969-March 15, 1970. Stone, William H. (Wisconsin Univ., Madison. Lab. of Genetics. UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Contract AT(11-1)-1210. 22p. Dep. CFSTI.

Investigation of the effects of whole-body ^{60}Co γ irradiation on the state of chimerism and immunologic tolerance in cattle twins revealed that fractionated doses (25 to 50 R/week) caused significant shifts in the proportions of the two hematopoietic tissues in the chimeras. Furthermore, the chimeric twins exhibited partial tolerance for skin grafts (neither irradiation nor other immunosuppressive agents affected this tolerance) and complete tolerance for kidney grafts. In the search for erythrocyte hybrids in the chimeric cattle, two cases of somatic cell mating were found. Viruses are being used to enhance the occurrence of this type of mating. Attempts to produce chimeras artificially by transplanting hematopoietic tissues directly into the fetus or embryo in utero are being continued. Signs of chimerism have appeared, but more data are required before conclusions can be drawn. Comparison of the chimeric condition based on erythrocyte antigens and on lymphocyte types revealed marked differences in antigenic factors as was expected for a state of split tolerance. Four previously unknown markers were produced during studies of genetic polymorphisms (allotypes) of immunoglobulin proteins in cattle. In studies of the soluble J-substances in cattle blood groups, a high molecular weight lipoid substance was detected in sera that inhibits or blocks the coating of erythrocytes in vitro by soluble J-substance in serum. Phylogenetic analyses of the microevolution of domestic cattle breeds have resulted in the production of several phylogenetic trees that agree with the historically documented breed relationships. Investigations were also conducted on the inheritance of electrophoretic variation of glucose-6-phosphate dehydrogenase and 6-phosphogluconate dehydrogenase in several species of Streptopelia (doves) and in Columba livia (domestic pigeon). Results of these studies were published elsewhere. In studies of the blood groups of Rhesus monkeys, 12 specific blood typing reagents were produced. Genetic studies indicated that the 12 blood factors reacting with these reagents were distributed among five independent blood group systems. (E.R.B.)

39441 (SAN-410-106) BASIC STUDIES OF THE IMMUNE RESPONSE AND THE EFFECTS OF RADIATION ON THIS RESPONSE. Progress Report, June 1, 1969-May 31, 1970. Dixon, Frank J. (Scripps Clinic and Research Foundation, La Jolla, Calif. Dept. of Experimental Pathology). Contract AT(04-3)-410. 13p. Dep. CFSTI.

The cellular kinetics of the induction of immunological unresponsiveness to deaggregated HGG (tolerogen) in mice were determined using a modification of the Jerne hemolytic plaque assay. At various times after injection of the deaggregated HGG into mice the spleens were removed and the washed spleen cells injected into irradiated syngeneic recipients with aggregated HGG (immunogen). The response to HGG in irradiated mice could be reconstituted with both thymus and bone marrow cells but not with either thymus or bone marrow cells alone. Other studies were conducted on immunology of human anti-GBM glomerulonephritis, immunopathology of renal homografts, etiologic agents in human immune complex glomerulonephritis, quantitation of immunologic events in experimental immune complex induced glomerulonephritis, pathogenesis of chronic viral infections, pathogenesis of allergic orchitis, termination of immunological unresponsiveness, immune reactions in thyroiditis, the subunit structure of mouse gamma A, characterization of a new mouse immunoglobulin, the effect of heat aggregation of human gamma G, the effect of aggregation on Cl binding, and structure of duck immunoglobulin. (H.L.W.)

39442 (SAN-410-107) BASIC STUDIES OF THE IMMUNE RESPONSE AND THE EFFECTS OF RADIATION ON THIS RESPONSE. Comprehensive Report, October 1, 1961-May 31, 1970. Dixon, Frank J. (Scripps Clinic and Research Foundation, La Jolla, Calif. Dept. of Experimental Pathology). Contract AT-(04-3)-410. 32p. Dep. CFSTI.

A summary is presented of research accomplishments over the past nine years. Research included studies on effects of x radiation on antibody formation; alteration of cellular events of immunity by radiation; immunological unresponsiveness; tolerance to

autologous thyroglobulin; etiology and immune reactions in glomerulonephritis; pathogenic mechanisms in chronic and latent viral infections; and structure and metabolism of immunoglobulin molecules. Plans for future research include studies on glomerulonephritis; use of x radiation in determining the role of macrophages in immune reactions; effects of x radiation on antigen receptors of lymphocytes; effector mechanisms in autoimmune disease; cellular kinetics of immunological unresponsiveness; and immune reactions in thyroiditis. (H.L.W.)

39443 (TID-25446) EFFECTS OF RADIATION AND IMMUNOSUPPRESSIVE DRUGS ON ANTIBODY FORMATION AND ALLERGY. Progress Report, September 1, 1968–November 31, 1969. Jennings, B. R. ([Tennessee Univ., Memphis]). Contract AT(40-1)-3489. 10p. Dep. CFSTI.

Tetanus toxoid (2.4 to 9.6 Lf dosages) was administered to mice and they were later treated with 100 R x radiation, actinomycin D, or both. Thirty-four days after the antigenic stimulus the mice were bled and the serum was titrated for antitoxin concentration. When irradiation was administered alone a stimulation of the antitoxin response was noted with an antigen dose of 9.6 Lf; when actinomycin D was administered alone there was an enhancement of response with the lowest antigen dose (2.4 Lf). When actinomycin D and irradiation were administered simultaneously, suppression of the response was evident with all dosages. In other experiments using sheep erythrocytes as the antigen, similar results were obtained. (H.L.W.)

39444 ROLE OF NONLYMPHOID ACCESSORY CELLS IN THE IMMUNE RESPONSE TO DIFFERENT ANTIGENS. Shortman, Ken; Diener, E.; Russell, Pamela; Armstrong, W. D. (Walter and Eliza Hall Inst. of Medical Research, Melbourne). J. Exp. Med.; 131: 461-82(1 Mar 1970).

Tissue culture techniques were combined with cell separation procedures to investigate the cellular requirements for a response to antigen leading to the production of antibody-forming cells. Mouse spleen was dissociated, and the cells were separated into various groups on the basis of density, size, and active adherence. The ability of fractions to initiate a response in vivo, on transfer to an irradiated recipient, was compared to the response in vitro; and this ability was correlated with the presence or absence of phagocytic cells. Two different antigens were studied, sheep erythrocytes (SRC) and polymerized bacterial flagellin (POL). The results indicated that phagocytic cells are not required in the initiation of an immune response to POL. By contrast some accessory cell, possibly a phagocytic macrophage, is required for a response to SRC. The basis for this marked difference is discussed. (auth)

39445 SYNERGISTIC INTERACTION OF MACROPHAGES AND LYMPHOCYTES IN ANTIGEN-INDUCED TRANSFORMATION OF LYMPHOCYTES. Seeger, Robert C.; Oppenheim, Joost J. (National Inst. of Dental Research, Bethesda, Md.). J. Exp. Med.; 132: 44-65(1 Jul 1970,.

The role of macrophages and lymphocytes in antigen-induced transformation of lymphocytes was investigated. Lymphocytes and macrophages were obtained from inbred strain 13 guinea pigs that were either unimmunized or immunized with complete Freund's adjuvant (CFA) or tetanus toxoid in CFA. The transformation response to PPD or tetanus toxoid was assayed by tritiated-thymidine incorporation. Addition of macrophages to immune lymphocytes significantly increased their response to purified protein derivative (PPD) or tetanus toxoid. This was observed if the macrophages were immune or nonimmune, unirradiated or irradiated (3000 R), 99% pure, and peritoneal or alveolar in origin. Neither immune or nonimmune macrophages were able to induce nonimmune lymphocytes to respond to PPD or tetanus toxoid. When macrophages were incubated with PPD or tetanus toxoid and then washed, they stimulated immune lymphocytes to transform. An incubation time of ½ hr was adequate, however, 2 to 4 hr was optimal. These studies indicate that antigen-induced transformation of lymphocytes is greatly enhanced by macrophages; that macrophage-antigen interaction can antecede lymphocyte-antigen interaction and results in macrophages that are able to stimulate lymphocyte transformation; and that the immunological memory requisite to elicit specific transformation responses is a property of the lymphocyte and not the macrophage. (auth)

39446 SEPARATION OF NORMAL AND IMMUNE LYMPHOID CELLS BY ANTIGEN-COATED COLUMNS. ANTIGEN-BINDING CHARACTERISTICS OF MEMBRANE ANTIBODIES AS ANALYZED BY HAPTEN-PROTEIN ANTIGENS. Wigzell, H.; Maekelae, O. (Karolinska Institutet, Stockholm. Helsinki Univ.). J. Exp. Med.; 132: 110-26(1 Jul 1970).

Specific fractionation of immunologically competent cells derived from normal or immune animals was achieved by filtration through antigen-coated bead columns. This selective retention of the relevant reactive cells could be shown to produce a cell population, which after passage through the column would behave like a suspension rendered immunologically tolerant by classical means. The immunologically specific elimination of potential antibody-forming capacity of the filtered cells could be shown to affect the IgM and the IgG system to a similar extent. Analysis of the binding characteristics of the membrane antibodies responsible for this selective retention indicate striking similarities to those of the humoral antibodies produced against the antigen. Thus, the surface receptor could distinguish isolated haptenic groups on a foreign carrier background and the receptor of the hapten-reactive cells in the present system (high-rate antibody-forming cells against NIP) failed to combine with carrier specific determinants in analogy with the binding behavior of the serum anti-hapten antibodies. The binding of anti-hapten reactive cells to bead-attached haptens could be specifically inhibited by the presence of free hapten in the columnar fluid during cellular filtration. The results strongly suggest that the potential humoral antibody-forming cell has performed receptors on its outer surface with binding characteristics, indicating similarity, if not identity, to those of the eventual product of the cell, the humoral antibody. (auth)

39447 AN ANALYSIS OF GRAFT-VERSUS-HOST DISEASE IN SYRIAN HAMSTERS. II. THE EPIDERMOLYTIC SYNDROME: STUDIES ON ITS PATHOGENESIS. Streilein, J. Wayne; Billingham, R. E. (Univ. of Pennsylvania, Philadelphia). J. Exp. Med.; 132: 181-97(1 Jul 1970).

The epidermolytic syndrome that can be obtained at will in F_1 hybrid hamsters by the cutaneous inoculation of adequate doses of parental strain lymphoid cells was investigated to determine whether the cutaneous lesions were due to an autoimmune process arising from the severe, initial GVH reactions in the skin. It was amply demonstrated that inoculation of donor cells into the skin was of crucial importance to the development of epidermolysis. Parental strain lymphoid cells in similar doses delivered by any other route into normal F_1 hybrids failed absolutely to incite the acute syndrome. If immune lymphocyte transfer reactions incited by donor cells in the host's skin were surgically removed at timed intervals after inoculation, only complete excision within 24 hr prevented the appearance of epidermolysis in F_1 hybrid hosts, indicating that inoculated donor cells must remain within the confines of the skin for approximately 24 hr in order to evoke the disease, persistence for longer periods of time being unnecessary for the subsequent course of the disease. However, reconstitution experiments involving the intramuscular inoculation of suspensions containing mixtures of donor cells and host lymphoid cells, in the presence or absence of epidermal cells, unequivocally indicated that no intimate exposure of lymphoid cells to putative skin-specific antigens was essential. Similarly, the elicitation of generalized epidermolysis in F_1 hybrids irradiated with 300 r and then inoculated intravenously with donor cells casts further doubt on the pathogenic importance of the skin as a source of tissue-specific antigen. The results of subsequent experiments indicated that host leukocytes, rather than parenchymal cells of the dermis or the epidermis, were important contributors of the transplanation antigenic stimulus. Moreover, a series of experiments using (CB × MHA) F_1 hybrid hosts that had been lethally irradiated and reconstituted with bone marrow cells from ALS-treated donors, indicated that from 6 to 10 wk after reconstitution—when direct and immune lymphocyte transfer reactions showed a virtual absence of native F_1 leukocytes from the circulation—donor cells obtained from specifically sensitized MHA donors were completely ineffective in inducing epidermolysis, while equivalent lymphoid cell inocula derived from CB donors evoked the cutaneous disease irrespective of the time elapsed since reconstitution. To explain these findings it is postulated that in hamsters, the primary targets in graft-versus-host disease incited by the intracutaneous inoculation of donor cells are leukocytes originating in bone marrow or lymph node, or both. (auth)

39448 CONTACT SENSITIVITY IN THE MOUSE. IV. THE ROLE OF LYMPHOCYTES AND MACROPHAGES IN PASSIVE TRANSFER AND THE MECHANISM OF THEIR INTERACTION. Asherson, G. L.; Zembala, M. (London Hospital Medical Coll. Medical Academy, Krakow). J. Exp. Med.; 132: 1-15(1 Jul 1970).

Contact sensitivity skin reactions were produced in mice by immunization with 2-phenyl-4-ethoxymethylene oxazolone (oxazolone) and detected by the increase in ear thickness after challenging the ears with 2% oxazolone. These skin reactions can be transferred from immunized donors to irradiated recipients by peritoneal exudate cells induced by thioglycollate. The peritoneal exudate cells were separated into purified macrophage and purified lymphocyte populations. Both cell populations transferred skin reactions. However, their time course was different. The reactions produced by lymphocytes

were greater at 24 hr than at 12 hr while the reactions produced by macrophages declined slightly between 12 and 24 hr. The working hypothesis was formed that the peritoneal lymphocytes conveyed a factor (presumptive cytophilic antibody) to peritoneal macrophages that enabled them to transfer ear reactions. Experiment showed that peritoneal and lymph node lymphocytes from sensitized donors within a Millipore chamber conveyed a factor to macrophages outside the chamber that enabled them to transfer ear reactions. In contrast, peritoneal macrophages (from sensitized donors) within the chamber and peritoneal lymphocytes outside the chamber were inactive. These findings suggested that there are three modes of immunological tissue damage: hypersensitivity mediated by lymphocytes (classical delayed hypersensitivity), hypersensitivity mediated by circulating antibody (classical immediate type hypersensitivity), and hypersensitivity mediated by macrophages that have passively acquired a factor (macrophage-mediated hypersensitivity). (auth)

39449 AN ANALYSIS OF GRAFT-VERSUS-HOST DISEASE IN SYRIAN HAMSTERS. I. THE EPIDERMOLYTIC SYNDROME: DESCRIPTION AND STUDIES ON ITS PROCUREMENT. Streilein, J. Wayne; Billingham, R. E. (Univ. of Pennsylvania, Philadelphia). J. Exp. Med.; 132: 163-80(1 Jul 1970).

F_1 hybrid hamsters derived from genetically disparate strains develop a severe and often lethal cutaneous disorder when inoculated intracutaneously with immunologically competent lymphoid cells from either parental strain. The disease is characterized clinically by extensive epidermal necrolysis, and histologically by a complete dissolution of the dermal-epidermal junction. The requisites for elicitation of this syndrome were determined to be: the parental strains must differ from each other at a major histocompatibility locus, and the donor inoculum must contain immunologically competent parental strain cells. In addition it was found that specifically sensitized cells surpassed normal unsensitized ones in their ability to elicit the disease, and that the disease can be transferred adoptively from affected to normal F_1 hosts by means of lymphoid cells. On the basis of these observations, it was concluded that the disease was immunologic in nature, and graft-versus-host in type. However, a series of critical studies failed to demonstrate that the epidermolysis had an immunogenetically specific basis, thus invalidating the provisional assumption that this lesion resulted from a direct immunologic attack upon parenchymal cells of the epidermis and dermis. With the aid of radiation chimeras, it was clearly established that typical epidermolysis could be induced in skin of the same genetic constitution as the attacking donor lymphoid cells. This paradox was taken into account by the possibility that, amid the intense local cutaneous graft-versus-host reactions skin-specific antigenic determinants are bared which incite a quasi autoimmune response that in turn is responsible for the epidermolytic lesions. (auth

Ecology

Refer also to abstracts 39046, 39075, 39076, 39412, and 39425.

39450 (AECL-3451) BIOLOGY AND HEALTH PHYSICS DIVISION PROGRESS REPORT, JULY 1-SEPTEMBER 30, 1969. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). 51p. (PR-B-83). Dep. CFSTI (U. S. Sales Only). AECL $1.50.

Four sections are presented: topical summary; biology report; environmental research report; and health physics report. The first section discusses trace elements and their importance to living things in relation to the waste radioisotopes from power reactors. Analytical instruments and methods are crucial to research on these trace elements. The second section briefly outlines the research in the fields of biochemistry and molecular biology (studies on RNA molecules, radiation biochemistry, radiomimetic chemicals, repair of DNA in bacteria, and structure of nucleoprotein) and genetics, development and population studies (studies on radiation repair in insects, microbial genetics, and vertebrate and human genetics). The third section outlines research involving biological and physical studies, meteorological studies, chemical studies, soil studies, and radiochemical analysis studies. Aquatic situations of the Chalk River area are of particular interest. The last section outlines research on neutron dosimetry and monitoring, cross-section calculations, criticality dosimetry using rhodium, and various dosimetry and monitoring methods for application in environmental studies. (C.O.)

39451 (AHSB(S)R-135) ASSESSMENT OF ENVIRONMENTAL HAZARDS FROM REACTOR FISSION PRODUCT RELEASES. Beattie, J. R.; Bryant, Pamela M. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). May 1970. 88p. Dep. UK 12s.

Information is reviewed pertaining to quantities of fission products formed in the fuel of large power reactors, the likelihood of certain of these escaping if an accident occurred, modes of dispersion and deposition of accidental discharges to the atmosphere, ways in which radiation dosage could be received downwind of a release, and the magnitude of such doses in various weather conditions and at different distances downwind. Possible consequences are depicted of the low probability accidents commonly postulated for AGR, PWR, BWR and SGHW type reactors, which use UO_2 pellets in metal cans. Similar considerations may apply to certain accidents possible with HTGR and LMFBR type reactors, in which fuel might, for example, become exposed to air in a refueling accident. Calculations embody recent moderate relaxations in emergency reference levels of activity concentrations, which are due to improvements in the radiobiological data. Conclusions reaffirm the importance of I as a primary source of hazard by inhalation, and by ingestion through milk and other foods. It is concluded that the whole body dose from the cloud is only a serious hazard if the release is very large and also within 1 km or so downwind of the reactor. Supplementary graphs are given for separate evaluation of hazards from Sr, Cs, Ru and the noble gases. (auth) (UK)

39452 (BMI-171-31) DARIENITA'S DIETARY. Bioenvironmental and Radiological-Safety Feasibility Studies, Atlantic-Pacific Interoceanic Canal. Duke, James A. (comp.) (Battelle Memorial Inst., Columbus, Ohio). 12 Jun 1970. Contract AT-(26-1)-171. 112p. Dep. CFSTI.

Dietary studies in Panama and Colombia were designed to quantify per-capita food consumption so that it could be determined what quantity of radionuclides would be ingested by natives following nuclear excavation of a sea-level canal. The content of ^{137}Cs, ^{239}Pu, and ^{90}Sr in various foods was analyzed and results are tabulated. Other tables are presented to show contents of stable elements in various foods, plant and animal foods of Isthmian people, and standard bromatological analyses of Isthmian crops and animal products. A list of approximately 1200 Darien recipes is appended. (H.L.W.)

39453 (BMI-171-33) BIOENVIRONMENTAL AND RADIOLOGICAL-SAFETY FEASIBILITY STUDIES ATLANTIC-PACIFIC INTEROCEANIC CANAL. DARIEN MOLLUSK DIETARY. Duke, James A. (comp.) (Battelle Memorial Inst., Columbus, Ohio). Apr 30, 1970. Contract AT(26-1)-171. 94p. Dep. CFSTI.

Discussions are presented of the economic uses of molluscs with emphasis on their use as food by man, predators of molluscs, feeding habits of molluscs, and accumulation of minerals by molluscs. Studies are reported on the accumulation of ^{95}Zr, ^{95}Nb, ^{144}Ce, ^{106}Ru, ^{137}Cs, ^{54}Mn, ^{65}Zn, and ^{40}K by clams, mussels, oysters, and scallops. A catalog of approximately seven hundred genera of molluscs from Panama and Colombia with notes on their ecology is presented. (approximately 180 references). (H.L.W.)

39454 (BMI-171-127) FRESHWATER VERTEBRATE AND INVERTEBRATE ECOLOGY OF AMCHITKA ISLAND, AMCHITKA BIOENVIRONMENTAL PROGRAM. Annual Progress Report, July 1, 1968-June 30, 1969. Neuhold, John M.; Helm, William T. (Utah State Univ., Logan). Apr 1970. Contract AT(26-1)-171. 50p. Dep. CFSTI.

For Battelle Memorial Inst., Columbus, Ohio.

The data collected during the fiscal year starting July 1, 1968 were, in part, analyzed and presented in this report. Estimates are given for stream primary production, detritus and dissolved organic content (carbon content), invertebrate populations, and fish populations. Salmon spawning on the Island is regarded as minimal in terms of contributing to the commercial salmon fishery. Most liberal estimates of silver salmon production on the Island amounted to only 1,600 smolts. Similarly, the streams on the Island were estimated to produce approximately 8,000 pink salmon fry to the marine environment. Some evidence existed for intertidal spawning by pink salmon, but no estimate could be hazarded here. Essentially, the data collected during the year corroborated the data collected during fiscal year 1968, that is, that the food-energy economics base of the lakes and streams under investigation are primarily detritus based, judging from the food ingested by the Dolly Varden and the threespine stickleback. Some variation, however, was experienced in the quality of food ingested by both the Dolly Varden and threespine stickleback. This quality varied with the season. During the summer portions of the year, some herbivorous insects were found in significant quantities in the fishes' guts. These included caddisflies and mayflies. In addition, the Dolly Varden did take threespine stickleback in the wintertime. The data collected, when converted to biomass production, yielded models that gave confidence that estimates of energy flow would be reliable. (auth)

39455 (BRH/NERHL-70-1) AN ESTIMATE OF RADIATION DOSES RECEIVED BY INDIVIDUALS LIVING IN THE VICINITY OF A NUCLEAR FUEL REPROCESSING PLANT IN 1968. Shleien, B. (Bureau of Radiological Health, Winchester, Mass. Northeastern Radiological Health Lab.). May 1970. 19p. CFSTI.

The public health implications associated with a nuclear facility can be best evaluated in terms of the radiation dose delivered to persons in the vicinity of the facility. This report attempts, by use of the dose commitment concept and surveillance data previously collected, to estimate radiation doses in 1968 to persons in the vicinity of a fuel reprocessing plant from ingestion and inhalation. The dose commitment accrued in 1968 to a hypothetical "typical individual" is not thought to differ significantly from that for the average adult population in the rest of New York State and is attributable essentially to fallout. This commitment was 77 millirem from ^{90}Sr to the bone and 1.7 millirem whole body from ^{137}Cs delivered over a 50-year period. For the hypothetical "maximum individual" the dose commitment to the bone from ^{90}Sr is 532 millirem and the first-year dose following ingestion is 38 millirem. The whole-body dose from ingestion of ^{137}Cs and ^{134}Cs (mostly from deer meat) is 257 millirem. Preliminary data indicate that the external γ dose above natural background is approximately 1.2 millirem per year to the "maximum individual." Estimated doses from tritium and ^{85}Kr were negligible (~2 millirem/year). (auth)

39456 (NIRS-8, pp 63-79) ENVIRONMENTAL STUDIES. (National Inst. of Radiological Sciences, Chiba (Japan)).

Brief papers or abstracts are presented for five environmental research projects conducted at NIRS during fiscal 1968. The investigations include: factors affecting ^{137}Cs retention in young rats; transfer of ^{137}Cs through placenta and milk in mice; whole-body retention and intestinal absorption of ^{144}Ce and ^{106}Ru in young mice; fallout ^{137}Cs in beer; and coagulation methods for treatment of radioactive wastes dissolved in seawater. (E.R.B.)

39457 (NP-18199) TIMING AND ABUNDANCE OF FISHES NEAR PRESCOTT, OREGON IMPORTANT TO THE COMMERCIAL OR SPORT FISHERIES OF THE COLUMBIA RIVER. I. SPECIES OF IMPORTANCE TO THE COMMERCIAL OR SPORTS FISHERIES. II. UPSTREAM MIGRANTS. III. DOWNSTREAM MIGRANTS AND RESIDENT FISHES. Supporting Final Report Observations. Coutant, Charles C.; Becker, C. Dale (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1968. 100p.

For Portland General Electric Co., Oreg.

To accurately assess potential effects of thermal discharges into the Columbia River near Prescott, Oregon, it is necessary to have a descriptive account of the occurrence and abundance of the principal aquatic species at or near that location. Available data pertinent to this objective are summarized. Practical restrictions have dictated that only species of fish directly important to commercial or sport interests be included in detail at this time. Hopefully, the account can be extended at a later date to include other organisms important to the dynamic ecosystem of the river. Fishes found at Prescott considered to be of sufficiently direct value to man to be included in this presentation are: four species of Pacific salmon, the chinook or king [Oncorhynchus tshawytascha (Walbaum)], the sockeye or blueback [O. nerka (Walbaum)], the coho or silver [O. kisutch (Walbaum)], and the chum or dog [O. keta (Walbaum)]; the steelhead trout (Salmo gairdneri Richardson); the cutthroat trout (Salmo clarki Richardson); the American Shad (Alosa sapidissima Wilson); the white sturgeon (Acipenser transmontanus Richardson); and the eulachon or Columbia River smelt (Thaleichthys pacificus Richardson). The rationale behind this choice and a brief description of the importance of each of these species to the commercial or sport fishery or both are included in Section One. Each of the above species is migratory; all but the white sturgeon are anadromous, entering the river from the ocean for spawning purposes. The sturgeon undergo seasonal movements up and down the river. Because of their migrations, the number of species of fishes and the number of each species that occur in the river near Prescott undergo dramatic seasonal changes—from month to month and even from year to year. The objective has been to determine the timing of these migrations, with respect to both adult and juvenile stages as well as local spawning populations. Section I reviews the species of fish important to the commercial or sport fishery in the Columbia River. Section II summarizes available data on ascending runs of anadramous species and on the movements of white sturgeon. Section III considers the movements of juvenile fishes in their descent to the sea, and lists the species resident in the lower Columbia and its estuary. (auth)

39458 (NP-18215) ESTUARINE RADIOECOLOGY. A Bibliography of Report Literature. Bibliography Series No. 16. Lattimer, John M. (comp.) (Office of Library Services, Washington, D. C.). Mar 1970. 52p. CFSTI.

Two hundred and nineteen references are presented to technical reports published from 1960 through June 1969 concerned with the biological accumulation and cycling of radioisotopes, radioactive sediments, and the effects of radiation on the biota associated with estuaries of the USA. (C.H.)

39459 (ORNL-4446) HEALTH PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JULY 31, 1969. (Oak Ridge National Lab., Tenn.). Oct. 1969. Contract W-7405-eng-26. 342p. Dep. CFSTI.

Separate abstracts were prepared for 21 of the 23 sections in this report. The other two sections discuss the theoretical physics of tissue damage and stable element metabolism in man. Also included in the report are discussions of cooperative projects and graduate education and vocational training programs of the division. A list of theses, papers, publications, and lectures by the personnel of the division and an organizational chart of the division are also included. (E.R.B.)

For abstracts of individual sections see: 39038, 39092, 39173–39175, 39221, 39369, 39370, 39460–39466, 39504, 39505, 39809, 39852, 39853, and 40183.

39460 (ORNL-4446, pp 26-39) DOSE ESTIMATION RELATED TO PEACEFUL USES OF NUCLEAR EXPLOSIVES. Jacobs, D. G.; Kelly, M. J.; Cowser, K. E.; Kaye, S. V.; Rohwer, P. S.; Struxness, E. G.; Snyder, W. S. (Oak Ridge National Lab., Tenn.).

The role of Project Gasbuggy in evaluating the feasibility of the use of nuclear explosives to stimulate low-productivity oil and gas reservoirs is discussed. Limits of detection of radionuclides in gas from the Gasbuggy well are tabulated for ^{90}Sr, ^{125}Sn, ^{131}I, ^{14}C, ^{127}Sb, ^{129m}Te, ^{125m}Te, ^{137}Cs, ^{125}Sb, ^{106}Ru, and ^{103}Ru. Argon-37, ^{85}Kr, and tritium were the only radioisotopes found in significant concentrations in gas samples removed from the well in November 1968. Gas collection and processing in the San Juan Division of the El Paso Natural Gas Company are described. Methods for estimating household dilution of natural gas combustion products are discussed. Effects of a continuously decreasing concentration of radionuclides at the wellhead on the dose to users of Gasbuggy gas are described. Procedures for estimating the potential dose to man as a part of a feasibility study of the use of nuclear explosives to excavate a sea-level canal across the isthmus of Central America are discussed. (H.L.W.)

39461 (ORNL-4446, pp 41-65) RESPONSES OF ANIMAL POPULATIONS TO IONIZING RADIATION. Auerbach, S. I.; Bardill, E. A.; Blaylock, B. G.; (and others) (Oak Ridge National Lab., Tenn.).

Models were developed for prediction of radiation effects in animal compartments of ecological systems and comparative measurements and interpretations of consequences of acute and chronic irradiation in wild species of animals were made. Construction of a field facility and contamination of enclosures with ^{137}Cs-tagged fallout simulant permitted initiation of field studies on dosimetry, movement of fallout particles, ^{137}Cs incorporation into the biota, environmental factors that affect cesium movement, and radiation effects on the animals within the enclosures. Progress is reported on application of LiF crystals in ecological radiation dosimetry; effects of chronic β radiation on Folsomia (Collembola); simulated fallout radiation effects on earthworm populations; ^{137}Cs whole-body burdens, tissue concentrations, and radiation doses to cotton rats in contaminated enclosures; effects of γ radiation on hive economy and pollinating activities of honeybees; applications of correlation matrices to investigations of community dynamics; effects of temperature and radiation stress on survival of isopods; population genetics and effects of radiation on Drosophila melanogaster, D. simulans, and Chironomus riparius; effects of chronic γ radiation on snail reproduction; radiation sensitivity and temperature effects in Gambusia; effects of β and γ radiation on carp reproduction; radiosensitivity of the newt (Notophthalmus viridescens); comparative radiosensitivity of red squirrels, eastern chipmunks, flying squirrels, Mongolian gerbils, toads, and tadpoles; and incorporation of ^{59}Fe in cotton rats. (H.L.W.)

39462 (ORNL-4446, pp 66-75) RESPONSES OF PLANTS TO IONIZING RADIATION. Harris, W. F.; Macklin, Carol E.; Suzuki, S.; Taylor, F. G. Jr.; Witherspoon, J. P.; Thomas, W. A. (Oak Ridge National Lab., Tenn.).

A fallout simulant consisting of quartz particles containing ^{134}Cs was applied to potted 2-yr-old white pine and red oak trees placed in an open field. Three plants of each species were collected at intervals up to 33 days for radioactivity determinations which were made with a γ spectrometer. Effects of weathering,

wind and rain, on particle retention were studied and results are shown by a graph. It was found that concentration of radionuclides on fallout-contaminated plants can be expected to decrease at rates significantly faster than would be predicted on the basis of radioactive half-lives. Beta radiation doses to various plant parts were measured in a number of different exposure geometries created with $^{90}Sr-^{90}Y$ sources; the LiF dosimetry system was used. Studies on effects of external β radiation on higher plants included determinations of lethal doses of $^{90}Sr-^{90}Y$ radiation in apical meristems of white pine, red oak, eastern cottonwood, cocklebur, green bean, tomato, wheat, and soybean. A study on the effects of acute, sublethal β radiation on potassium and phosphorus uptake in bean plants (Phaseolus vulgaris) was completed. Results indicated that under chronic radiation, stress changes in nutrient budgets may affect survival of plants growing on sites of low fertility. Ecological responses of trees to fast neutron radiation and reduced light intensities were studied. Seedlings of the shade-intolerant yellow poplar and the shade-tolerant silver maple were given doses of 200, 300, and 400 rads. Analyses of root-shoot ratio and photosynthetic responses tended to support the hypothesis that sublethal radiation stress narrows the ecological amplitude of a taxon, that is, the degree to which the organism can tolerate environmental stress. For studies on effects of radiation on decomposition of leaves, persimmon leaves were collected as they fell from trees growing 15 m from the unshielded Health Physics Research Reactor. On the same collection dates leaves were obtained from control trees about 200 m from the reactor and shielded from radiation by a hill. About 80% of the irradiated leaves displayed apparent abnormalities, such as thickening, whereas all control leaves had smooth normal leaf blades. (H.L.W.)

39463 (ORNL-4446, pp 76-112) RADIONUCLIDE CYCLING IN TERRESTRIAL ECOSYSTEMS. Anderson, Regina M.; Baker, C. E.; Brinkley, F. S.; (and others) (Oak Ridge National Lab., Tenn.).

Ecosystem research on radionuclide cycling concentrated on a long-lived fallout radionuclide, ^{137}Cs, in two contrasting ecosystems: a mesic Liriodendron forest and a Festuca-Andropogon grassland. Plant production and food-chain studies examined pathways and fluxes of important nutrient elements in these ecosystems using radioisotopes. Studies on Liriodendron forests tagged with ^{137}Cs included trends in canopy content of ^{137}Cs in tagged trees; seasonal pattern and components of litterfall; distribution and loss of ^{137}Cs from roots by leaching of seedlings grown in sand culture; accumulation and distribution of ^{137}Cs in soils; population density and biomass of soil microinvertebrates; seasonal density and biomass of forest floor invertebrates belonging to the following groups: Araneae, Chilopoda, Coleoptera, Collembola, Diplopoda, Diptera, Hymenoptera, Lepidoptera larvae, Orthoptera, and Pulmonata; seasonal energy budgets for forest spider populations; secondary production of bagworms, Thyridopteryx ephemeraeformis, on different host plants; biological turnover of radionuclides; and construction of a model for ^{137}Cs movement in a forest floor community. Studies were conducted on respiration rates of Acheta domesticus acclimated to a fluctuating daily temperature regime. Accumulation of ^{144}Ce and ^{60}Co by seedlings of hickory, black gum, red maple, tuliptree, and white oak was investigated. Measurements were made of decomposition and loss of ^{144}Ce, ^{137}Cs, and ^{60}Co from leaves of black gum, hickory, and tuliptree. Studies on interaction between grass communities included determination of broomstraw invasion of a fescue grassland over a two-year period at an old-field study site in the 0800 ecology area. Investigations of fescue meadows included correlation of predicted and observed ^{137}Cs in runoff from contaminated plots; hydrologic balance; behavior of ^{137}Cs fallout simulant; compartment model of seasonal change in roots, tops, and dead biomass; short-term effects of cover management on decomposition processes in soil; pesticide-induced responses in organic matter decomposition; toxicity of fescue extract to soil bacteria; characterization of particulate organic matter in old-field and forest soils; temperature dependence of ^{47}Ca, ^{42}K, and ^{22}Na turnover in arthropods; kinetics of ^{137}Cs and ^{54}Mn in sand-grass-grasshopper systems; energy budget for wolf spiders (Lycosa rabida); energy dynamics of a terrestrial snail (Mesodon thyroidus); avoidance of dead grass cover by pine mice; the concept of using radionuclides (^{137}Cs and ^{59}Fe) for metabolic measurements in small mammals. (H.L.W.)

39464 (ORNL-4446, pp 113-36) RADIONUCLIDE CYCLING IN AQUATIC ECOSYSTEMS. Brown, Evelyn; Gammon, J. R.; Griffith, N. A.; (and others) (Oak Ridge National Lab., Tenn.).

Laboratory studies in conjunction with field work on White Oak Lake provided data for predictive models of nonsteady-state situations. The data are pathway descriptions, turnover rates, and fractional assimilation coefficients of radionuclides from various foods. Data are presented from studies on accumulation of ^{181}W from water by black bullheads and crayfish; turnover of ^{60}Co, ^{137}Cs, ^{54}Mn, ^{85}Sr, and ^{65}Zn in the aquatic plants, duckweed and wild celery; uptake and retention of ^{59}Fe, ^{181}W, and ^{65}Zn in the newt, Notophthalmus viridescens; determination of feeding rates in Trichoptera using ^{60}Co; the role of aerobic microbes in the cycling of ^{35}S in an aquatic ecosystem; kinetics of ^{60}Co, ^{137}Cs, and ^{42}K in microcosms; balances of ^{137}Cs, stable Cs and K in bluegill; and concentrations and specific activities of ^{137}Cs, stable Cs and K in seven species of fish in White Oak Lake. (H.L.W.)

39465 (ORNL-4446, pp 137-52) WATERSHED AQUATIC HABITAT INTERACTIONS. Abner, C. H.; Bonner, W. P.; Curlin, J. W.; (and others) (Oak Ridge National Lab., Tenn.).

The Walker Branch Watershed project was organized to assess the potential ecological impact of new technology being applied to the field of natural resource management. A compartment model is illustrated for evaluation of transfer rates and characteristics of the transfer functions among the principal components of the watershed ecosystem. Chemical input and output are estimated weekly for Ca, Mg, Na, K, N, and P from stream water, rainwater, and dry particulate deposition; results are shown by means of graphs. Terrestrial studies were conducted on transfer of ions and water through soil. Red maple litter containing ^{45}Ca was spread on the plot and soil cores were removed at four-week intervals to monitor ^{45}Ca movement in the soil profile. Seventy-five per cent of the labeled litter remained on the plot 12 weeks after input. Preliminary experiments with ^{47}Ca indicated that the distribution of water-soluble calcium in the soil is dependent on moisture conditions. Experiments were conducted on decomposition and mineralization of leaves of red maple, tuliptree, and white oak under terrestrial and aquatic conditions. A material balance study using ^{32}P and periphytic algae in a closed system in the laboratory was conducted to obtain data on uptake and turnover of phosphorus by stream diatoms. (H.L.W.)

39466 (ORNL-4446, pp 153-62) SYSTEMS ECOLOGY. Baskerville, G.; Dean, F. C.; Bledsoe, L. J.; Gove, N. B.; Kaye, S. V.; Olson, J. S.; O'Neill, R. V.; Sollins, Nancy F.; Sollins, P.; Williams, R. B. (Oak Ridge National Lab., Tenn.).

The purpose of the ecological systems analysis program is to develop a methodology for making useful predictions about the outcome of environmental interactions, both empirical and theoretical. Progress is reported on the following projects: pertinence of recent ecological literature to the modeling of ecosystems; biogeochemical ecology research collection; parameter identification in systems ecology; numerical methods in systems ecology; CSS: a versatile compartment system simulation program; a stochastic model of feeding in a forest centipede; a model for Cedar Bog Lake, Minnesota; analysis of the change-in-ratio model for estimating population abundance; and systems analysis of balsam forests. (H.L.W.)

39467 (RLO-2225-T-1-1) RADIOLOGICAL ASPECTS OF NUCLEAR POWER AND THE AQUATIC ENVIRONMENT. Seymour, Allyn H. (Washington Univ., Seattle. Lab. of Radiation Ecology). [1969]. 15p. (CONF-700415-1). Dep. CFSTI.

From Conference on Nuclear Power and the Environment, Madison, Wis.

A review is presented of the environmental effects of ionizing radiation and radioisotopes from the normal operation of nuclear power reactors, reactor accidents, and nuclear weapons testing. Estimates of the radionuclides discharged per day to the Columbia River from the Hanford plutonium production reactors are discussed. It is pointed out that the only nuclides occurring in significant amounts in fish of the Columbia River are ^{32}P and ^{65}Zn. Experiments on the effects of ^{51}Cr and ^{65}Zn on the embryonic development of oysters showed that the concentration of these isotopes in the oyster-growing areas at the mouth of the Columbia River was not significant enough to have any effect on growth of the oysters. The concentration of ^{106}Ru in the alga, Porphyra, used as food by man, is discussed with regard to the ICRP recommended dose limit. Factors to be considered in evaluating the contribution from nuclear reactor operations are the kinds and amounts of naturally occurring radionuclides and of fallout or other artificial radionuclides in the environment, the elemental composition of marine organisms, and a quantitative inventory of the biota. The specific activity and critical pathway approaches in the prediction of allowable amounts of radionuclides in the environment are discussed. (H.L.W.)

39468 (RLO-2225-T-1-2) COLUMBIA RIVER STUDIES. Annual Progress Report, 1969-1970. (Washington Univ., Seattle. Lab. of Radiation Ecology). 22 Jun 1970. Contract AT-(45-1)-2225. 7p. Dep. CFSTI.

Six research programs were completed or were in progress at the radiation ecology laboratory during the 1969 to 1970 reporting period. These include: effects of temperature and ionizing radiation on the larvae of the Pacific oyster; effects of shock temperature and ionizing radiation on phytoplankton; uptake of ^{55}Fe by mussels from the Washington coast (1962 to 1969); zinc biological half-life for oysters in a natural environment; dose measurements with thermoluminescent dosimeters; and monitoring of mussels from Washington waters for ^{65}Zn. Results from each phase of the research program are briefly discussed. (E.R.B.)

39469 (RT/PROT–(69)43) ECOLOGICAL STUDY OF THE C.R.N. SITE AT TRISAIA. Antonelli, A.; Rossi, L. Cigna; Laneri, U.; Lenzi, G.; Cassano, G.; Marzocchi, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 21 Oct 1969. 56p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The results of ecological research, performed at the site of the Trisaia Reprocessing Plant (along the Sinni River, near the Jonio Sea) before the beginning of the hot operations are reported. The main characteristics of the abiotic environment as well as the biological features of the ecosystems involved were examined. On the basis of the data collected and of a socio-ecological survey, two different ways for the discharge of low-activity liquid effluents from the plant are proposed. (auth)

39470 (STI/DOC–10/105) IAEA RESEARCH CONTRACTS. Tenth Annual Report. Technical Reports Series No. 105. (International Atomic Energy Agency, Vienna (Austria)). 1970. 225p. IAEA $6.00.

Summaries are presented of the final reports of 50 research contracts or agreements received during 1969 by the Agency's Research Contract Program of the IAEA. The summaries are organized into 11 categories including: radioactive waste management and related environmental research; health physics and radiation protection; radiation biology; safeguards methods; studies involving reactors; radioisotope applications in agriculture; radioisotope applications in medicine; radioisotope applications in hydrology; food preservation by irradiation; radioisotope applications in industry; and physics and chemistry. An appendix is included which contains a bibliography and author, corporate author, subject, and research contract number indexes. (E.R.B.)

39471 (TID–25393) SAVANNAH RIVER BIOLOGICAL SURVEY, SOUTH CAROLINA AND GEORGIA, MAY–AUGUST 1968. (Academy of Natural Sciences of Philadelphia, Pa. Dept. of Limnology). Apr 1970. 154p. Dep. CFSTI.

For Du Pont de Nemours (E. I.) and Co., Aiken, S. C.

Biological surveys were made of the Savannah River (Georgia and South Carolina) and two stations on Lower Three Runs Creek (South Carolina) in the vicinity of the Savannah River Plant. The purpose was to determine whether any physical, chemical, or biological changes had occurred since previous surveys during 1951 to 1965. Species identifications were made of algae, protozoa, turbellarian worms, annelids, snails, clams, insects, crustaceans, and fishes. Results are presented in the form of tables and graphs, and discussions are presented of the diversity of species in comparison to results of previous surveys and in relation to pollution of the water. Chemical, physical, and bacteriological studies were also carried out and the significance of the results are discussed in relation to pollution. (H.L.W.)

39472 (UCRL–50791) ASSESSMENT OF POTENTIAL BIOLOGICAL HAZARDS FROM PROJECT RULISON. Robison, W. L.; Anspaugh, L. R. (California Univ., Livermore. Lawrence Radiation Lab.). 18 Dec 1969. 35p. Dep. CFSTI.

Project Rulison, an underground nuclear detonation designed for the stimulation of natural gas reservoirs, was detonated on 10 September 1969. The evaluations of off-site radiological hazards associated with the proposed reentry and testing operations are reported. When flaring of the natural gas is begun, the major isotope to be released will be tritium (^{3}H). Therefore, several questions concerning the biology and physics of tritium are considered in the light of the data available in the literature. The general conclusions are that ordinary calculations of absorbed dose based on energy uniformly distributed throughout a volume are sufficient to describe the observed effects. No special mechanisms need be considered to account for the extent of the effects observed. Also, when animals are constantly exposed to ^{3}H, their organic molecules, especially their DNA, have ^{3}H–^{1}H ratios essentially the same as that of the body water. Thus, it appears that there is no increase in the incorporation of tritium into DNA as a result of the ingestion of tritiated DNA by ascending trophic levels. The concentration of ^{3}H in the environment seems to be the controlling factor. Dose estimates to the surrounding population from inhalation and food-chain pathways were also made from source terms predicted for the Project Rulison operation. From these dose estimates, the risks were calculated for genetic loss, leukemia, cancer, and nonspecific life-shortening for the individuals living in the vicinity of the Rulison site. If the maximum average estimated dose via the food chain is taken to be 20 mrem (a dose that can be reduced by employing appropriate precautions), the total detriment to the first generation (genetic loss plus nonspecific life-shortening) represents a possible increase of 0.007% over the natural incidence of genetic loss and malignancy. The increase could be zero. In the interest of public safety, these source terms, dose estimates, and risk calculations are made in a very conservative fashion such that upper-limit risks are reported. (auth)

39473 UNSOLVED PROBLEMS OF WATER RADIOECOLOGY. Polikarpov, G. G. (Inst. of Biology of the Southern Seas, Sevastopol, USSR). Radiobiologiya; 10: 242-52(Mar-Apr 1970).

On the basis of an analysis of the modern state of investigations in the field of the radioecology of water organisms, its most important unsolved problems, associated with determining the role of the physicochemical state of radionuclides in the radioecological processes of concentrations, disclosing the mechanisms of penetration, accumulation, and distribution of radionuclides in living systems and the participation of radioecology in the protection of nature are discussed. (auth)

39474 SEASONAL VARIATION AND DISTRIBUTION OF ^{65}Zn, ^{54}Mn, AND ^{51}Cr IN TISSUES OF THE CRAB CANCER MAGISTER DANA. Tennant, David A.; Forster, William O. (Oregon State Univ., Corvallis). Health Phys.; 18: 649-57(Jun 1970).

Crabs were collected from the Columbia River estuary and their tissues were measured for both stable and radioactive Cr, Zn and Mn during 1966–67. Specific activities and radioactivities fluctuated throughout the year in much the same manner. Maximum radioactivities seem to be related to river discharge while peak specific activities may be due to metabolic changes in the crab. Chromium-51 and ^{65}Zn accounted for nearly all of the gamma radioactivity in the tissues, ^{65}Zn being mainly concentrated in soft tissues and ^{51}Cr in hard tissues. Manganese-54 concentrations were highest in the setae and calcareous exoskeleton, presumably because of surface adsorbed $^{54}MnO_2$. Chromium-51 concentrated in the setae, gills and hepatopancreas suggested that both surface adsorption and physiological processes are instrumental in its accumulation. Zinc-65 is noticeably concentrated in soft tissues probably because of its enzyme role in metabolism. Surface adsorption seems to play a minor role in the accumulation by crab tissues of this radionuclide. Specific activities suggest that surface adsorbed radionuclides are turned over faster than absorbed radionuclides. (auth) (UK)

Genetics and Cytogenetics

Refer also to abstracts 39419, 39426, 39428, 39450, 39472, 39549, 39576, 39587, 39592, and 39593.

39475 (CONF-700612–1) INDUCTION OF MUTATIONS IN SOYBEANS FOR ENVIRONMENTAL ADAPTATION BY GAMMA RADIATION. Koo, F. K, S.; Cuevas-Ruiz, J.; Gutierrez-Colon, G. (Puerto Rico Nuclear Center, Rio Piedras. Puerto Rico Nuclear Center, Mayaguez). [1969]. 13p. (SM–132/36). Dep. CFSTI.

From Symposium on Plant Protein Resources, Vienna, Austria.

Seed of soybeans of two varieties (Hill and Lee) were exposed to 15 krad of γ radiation and planted in isolated plots. The seedlings were illuminated for 4 hrs. nightly for six weeks following emergence. Mature plants were harvested and threshed individually. Late flowering and/or late-maturing plants were marked in the field. The M_2 and M_3 progenies were examined for heat tolerance and maturity time. The mutants will be evaluated for characteristics of interest to plant breeders in tropical areas. (C.H.)

39476 (COO–332–8) GENETIC AND BIOCHEMICAL INVESTIGATIONS OF BARLEY CHLOROPLAST MUTANTS. Final Report. (Minnesota Univ., St. Paul). [1970]. Contract AT(11-1)-332. 6p. Dep. CFSTI.

Results are reported from investigation of barley (Hordeum vulgare) chloroplast mutants. A seed increase was obtained from greenhouse grown plants of most of the primary plastid mutants, the suppressors of a virido-xantha (vx) mutant, and the translocations and various other genetic stocks used in the studies. Primary interest consisted of growing additional seedling progenies of ethyl methanesulfonate-, x-ray-, and thermal neutron-treated material of the vx mutant. A large number of additional suppressor mutants, having phenotypes similar to those characteristic of mutants at the su-1 locus on chromosome 6, were selected and increased. These materials are expected to provide a

critical test of the indicated specificity of action of ionizing radiations and polyfunctional alkylating agents at the su-1 locus (at which 10 suppressor mutants induced with x rays or thermal neutrons and 1 mutant induced with trifunctional triethylene melamine were found previously) or the su-2 locus on the same chromosome (at which single mutants induced with x rays and thermal neutrons were found). Results failed to detect EMS-induced suppressor mutants at either of these loci among a sample of 45 suppressors induced with this agent and selected for analysis on the basis of phenotype. Twenty-five of the most recently obtained suppressors were crossed with mutant alleles representing both the su-1 and su-2 loci, as the first step in determining allelism. Analysis of these and the considerable number of new radiation-induced suppressor mutants that have not yet been crossed will yield information also relating to the unusual and not yet explained phenomenon that all of the radiation-induced suppressors that were examined in the first phase of the genetic studies were found to behave as recessives. A large number of additional mutants apparently affecting the chloroplast carotenoids and their precursors were selected from among progenies of EMS- and x-ray-treated normal Himalaya barley for analyses of the ultrastructure of chloroplasts. (C.H.)

39477 (JPRS-49928) SPACE BIOLOGY AND MEDICINE. Translation of Kosm. Biol. Med.; 3: No. 6, 3-83(1969). 130p. CFSTI.

A separate abstract was prepared for one article in the journal. An additional 16 articles are included on various aspects of space biology and medicine. (H.L.W.)

For an abstract of one paper see: 39478.

39478 (JPRS-49928, pp 45-50) PROLIFERATIVE ACTIVITY OF BONE MARROW IN DOGS DURING CHRONIC γ-IRRADIATION. Zukhbaya, T. M. Translated from Kosm. Biol. Med.; 3: No. 6, 3-83(1969).

The mitotic activity and chromosomal aberrations in the bone marrow of dogs exposed to chronic gamma irradiation in doses of 25, 75 and 150 R per year were studied. No noticeable changes were found in proliferative activity. An increase in chromosomal aberrations was seen in animals irradiated in doses of 75 and 150 R per year. (auth)

39479 (ORO-3728-3) A QUANTITATIVE STUDY OF THE MUTAGENIC EFFECT OF TRANSMUTATION IN DROSOPHILA AND THE HONEY BEE. Progress Report. (Louisiana State Univ., Baton Rouge). 14 Jun 1970. 15p. Dep. CFSTI.

Carbon-14-labeled thymidine was fed to male Drosophila melanogaster and they were mated to non-labeled females. Genetic tests were run on progeny that developed from eggs laid immediately after mating (group 1) and after a three-week storage period (group 2). It was calculated that a difference between groups 1 and 2 would be caused by transmutation of ^{14}C to ^{14}N during storage. Incorporation of ^{14}C was determined by dissecting the seminal receptacle from females and counting the number of sperm cells microscopically and their β emission with a liquid scintillation spectrometer. It was concluded that transmutation of ^{14}C within the DNA molecule like transmutation of ^{32}P does not break the eukaryote chromosome or induce lethal mutations that are present in all the cell lineage. (H.L.W.)

39480 (STI/DOC-10/102) RICE BREEDING WITH INDUCED MUTATIONS. II. Technical Reports Series No. 102. Report of an FAO/IAEA Research Co-Ordination Meeting Held in Oiso, Japan, 12-14 August 1968. (International Atomic Energy Agency, Vienna (Austria)). Mar 1970. 130p. (CONF-680848). IAEA $4.00.

Separate abstracts were prepared for eleven papers presented at the conference. An additional paper was presented on rice stem borers in Malaya. (H.L.W.)

For abstracts of individual papers see: 39483-39493.

39481 NEW IDEAS IN THE RADIATION GENETICS OF MAMMALS. Shapiro, N. I.; Pomerantseva, M. D. (Moscow State Univ. Inst. of General Genetics, Moscow). Radiobiologiya; 10: 167-87(Mar-Apr 1970).

The mutagenic effects of various types of radiations on mammalian germ cells, primarily premeiotic, are reviewed. The dependence of the yield of mutations on the radiation dose, the influence of the time interval between irradiation and mating on the yield of mutations, the role of dose distribution with time, and the effect of radiation on the value of the genetic load in mammalian populations are considered. An analysis of the available data permits it to be concluded that the effectiveness of the mutagenic action of radiation on the genomes of germ cells is lower than expected. This gives a basis for believing that during the process of evolution, protective mechanisms were developed, the action of which is directed toward protecting the premeiotic cells of mammals from the appearance of a large number of mutations. It is hypothesized that in the future the quantitative estimation of the genetic hazard of radiation will be reexamined and lowered. (auth)

39482 GENETIC EFFECTS OF X-RAY IN COMBINATION WITH STREPTOMYCIN ON ARABIDOPSIS THALIANA. Dhar, Sujit K. (Ellsworth Coll., Iowa Falls, Iowa). Proc. Iowa Acad. Sci.; 76: 69-73(1970).

From 79th Proceedings of the Academy of Science, Des Moines, Iowa. See CONF-690443.

Soaking seeds of Arabidopsis in 0.005% streptomycin (SM) produced no second generation chlorophyll mutants. But when seeds were soaked in 0.005% SM for 20 hours before x irradiation the percentage of chlorophyll mutants was lower than in plants obtained from seeds that were soaked in distilled water before exposure to x rays. It is suggested that this change in the radiosensitivity of Arabidopsis by SM is caused by chelation of Mn^{2+} with SM, thus causing a deficiency of the Mn^{2+} ion, which is essential for the integrity of the chromosomes. (auth)

39483 MUTATION INDUCTION IN RICE BY RADIATION COMBINED WITH CHEMICAL PROTECTANTS AND MUTAGENS. Ando, A. (Univ. of Sao Paulo, Brazil). pp 1-5 of Rice Breeding With Induced Mutations. II. Vienna; International Atomic Energy Agency (1970).

From 4th Meeting on Rice Breeding with Induced Mutations II, Oiso, Japan. See STI/DOC-10/102; CONF-680848.

Seeds of the rice variety Dourado Precoce were treated with different combinations of gamma rays, cysteine, and EMS or gamma rays, cysteine and diethyl sulfate. Cysteine showed some protection against the effects of gamma radiation and combined gamma-ray + chemical treatments with regard to germination, seedling height, and fertility. There are also indications of changes in the spectra of chlorophyll mutations. (auth)

39484 INDUCED MUTATION STUDIES WITH BRACHIARIA BRIZANTHA STAPF. AND SOME INDICA RICE VARIETIES FROM CEYLON. Ganashan, P. (Agricultural Research Station, Maha-Illuppallama, Ceylon). pp 7-12 of Rice Breeding With Induced Mutations. II. Vienna; International Atomic Energy Agency (1970).

From 4th Meeting on Rice Breeding with Induced Mutations II, Oiso, Japan. See STI/DOC-10/102; CONF-680848.

Non-imbibed seeds of Brachiaria brizantha were irradiated with doses of ^{60}Co gamma rays ranging from 7.5 to 75 kR and fresh stem cuttings containing three nodes were irradiated with doses ranging from 7.5 to 45 kR. Chromosome counts were made using the Carnoy method. There was no germination at 75 kR, and 18% germination at 60 kR with no survival of the seedlings. At the other doses germination and seedling survival decreased from 56% and 100% respectively for the control to 42% and 46% respectively at 45 kR. There were no chlorophyll mutants at 7.5 kR, while a few were observed among seedlings at the higher doses. In the stem cuttings establishment was poor and morphological variations were observed at all doses above 15 kR. A mutant of desirable plant type was obtained from the 45-kR seed treatment with an erect growth habit, reduced pubescence, short internodes, profuse tillering, and rapid regrowth compared with the parent. Four indica rice varieties, H-4, H-8, H-7 and Pachchaiperumal 2462/11 (PP 2462/11), were subjected to gamma rays, neutrons, and ethyl methane sulphonate (EMS) treatments. The LD_{50} level for gamma rays was 50 to 60 kR, for neutrons 1600 R and for EMS 0.4%. Germination and final plant stand in the M_1 generation were affected only slightly by the neutron treatments, but were greatly reduced by EMS, and gamma irradiation above 35 kR. The final plant stand of the variety PP 2462/11 was most reduced by all the mutagens. In the M_2 generation there was segregation for chlorophyll mutants, of the albina, chlorina, xantha, virescens, and zebrina types. Other macro-mutations observed were for grain size and shape, plant height, flowering date, and sterility. Grass clump types were found occasionally. (auth)

39485 PRESENT STATUS OF RICE BREEDING BY INDUCED MUTATIONS IN TAIWAN, REPUBLIC OF CHINA. Hu, C. H. (Taiwan Provincial Chung-Hsing Univ., Taichung). pp 13-19 of Rice Breeding With Induced Mutations. II. Vienna; International Atomic Energy Agency (1970).

From 4th Meeting on Rice Breeding with Induced Mutations II, Oiso, Japan. See STI/DOC-10/102; CONF-680848.

Since 1957, fourteen varieties, including both indica and japonica, have been treated with x rays, gamma rays, thermal neutrons, and EMS for inducing mutations. The objectives are: to obtain erectoid mutants of good lodging resistance from the tall native varieties which can be adapted for intensive culture; to obtain early maturing mutants with at least the same yield as the original variety, so

that the multiple cropping system of Taiwan can be easily handled; and to obtain disease-resistant mutants. The results obtained suggest that after a useful gene such as erectoid has been obtained by induced mutation, it can be used immediately. But in general, it will be more useful to combine this character into other genotypic backgrounds by cross-breeding. Henceforth, further breeding must be carried out by cross-breeding. A number of promising lines were selected from induced mutants after being crossed with local varieties and the advanced test of these lines is being carried on at present. (auth)

39486 RICE BREEDING WITH INDUCED MUTATIONS IN FRANCE. Marie, R. (Institut National de Recherches Agronomiques, Montpellier, France). pp 21-4 of Rice Breeding With Induced Mutations. II. Vienna; International Atomic Energy Agency (1970).

From 4th Meeting on Rice Breeding with Induced Mutations II, Oiso, Japan. See STI/DOC-10/102; CONF-680848.

Mutation experiments with rice at Montpellier yielded strains with improved lodging resistance, grain size, maturing time, milling quality, and other characters. The general performance of these mutant strains was tested in field trials. Further mutagenic treatments were made to improve the high-yielding short grain varieties with regard to grain quality and seed dormancy. Mutations were induced by γ and x radiation and EMS. (auth)

39487 MUTATION BREEDING IN RICE IN INDIA. Swaminathan, M. S.; Siddiq, E. A.; Singh, C. B.; Pai, R. A. (Indian Agricultural Research Inst., New Delhi). pp 25-43 of Rice Breeding With Induced Mutations. II. Vienna; International Atomic Energy Agency (1970).

From 4th Meeting on Rice Breeding with Induced Mutations II, Oiso, Japan. See STI/DOC-10/102; CONF-680848.

Mutation research was continued in rice with the following aims: to enhance the frequency and spectrum of mutations in indica and japonica rice varieties; to change the grain quality of the japonica variety, Tainan-3, into the indica type; to improve the grain quality of the indica variety, IR-8; to increase the recombination frequency in japonica-indica hybrids. Both nitrosoguanidine and 5 MeV fast neutrons gave a high mutation frequency. The japonica variety was more sensitive to all mutagens than the indica types. Chemical mutagens had no particular advantage over ionizing radiations with reference to either mutation frequency or spectrum. Mutants with indica type of grain occurred readily in Tainan-3 in all treatments. Such mutants had a larger grain length/width ratio and were more resistant to alkali digestion. Fine grain types with better cooking quality occurred in the M_2 populations of IR-8. These mutants are likely to render this high-yielding variety more popular. A wide range of chlorophyll and viable mutations occurred in IR-8 and Tainan-3. Some of these, like those involving dwarfing and slow senescence, are of economic interest, besides those affecting grain quality. Recombination frequency can be influenced in japonica × indica hybrids through the irradiation of F_1 sporocytes. The precise influence varies with the stage at which the plant is irradiated, the dose given, and the loci involved. (auth)

39488 HAPLOID RICE PLANTS IN MUTATION STUDIES. Tanaka, S. (Inst. of Radiation Breeding, Ibaraki, Japan). pp 45-56 of Rice Breeding With Induced Mutations. II. Vienna; International Atomic Energy Agency (1970).

From 4th Meeting on Rice Breeding with Induced Mutations II, Oiso, Japan. See STI/DOC-10/102; CONF-680848.

Studies were made on chlorophyll-deficient sectors and diploid-like sectors in haploid rice plants exposed to chronic gamma irradiation, and on germinal mutations in diploid strains derived from the haploid plants. The induction and elimination of somatic mutations in haploid plants and the occurrence of drastic germinal mutations in diploid strains from haploid plants are discussed. (auth)

39489 INDUCED MUTATIONS OF RICE FOR SHORT-CULM SELECTIONS IN M_2 GENERATION. Ree, J. H. (Yungnaim Crop Experiment Station, Milyang, Korea). pp 57-67 of Rice Breeding With Induced Mutations. II. Vienna; International Atomic Energy Agency (1970).

From 4th Meeting on Rice Breeding with Induced Mutations II, Oiso, Japan. See STI/DOC-10/102; CONF-680848.

Seeds of a leading rice variety Palkweng, japonica, were treated with x rays and thermal neutrons to obtain mutations having short culm, earliness, resistance to lodging and blast disease, and a high yielding ability. Five hundred and seven plants were selected for short-culm length; on the average they were also shorter in panicle length, lighter in weight of panicles, less in 100-grain weight, and earlier in days to heading. There was no strict correlation between culm length and panicle length. Some plants had longer panicles in spite of a distinct reduction in culm length, but the number of panicles, weight of panicle, and days to heading were positively correlated with culm length in the selected plants. The length of each internode from the base of the panicle down to the basal internode was gradually reduced. The lodging index was lower than that of the original variety, and culm length was positively correlated with lodging index. (auth)

39490 IMPROVEMENT OF RICE VARIETIES BY INDUCED MUTATIONS TO INCREASE YIELD PER ACRE AND RESISTANCE TO DISEASES AND TO IMPROVE SEED QUALITY. Miah, A. J.; Bhatti, I. M.; Awan, A.; Bari, G. (Atomic Energy Agricultural Research Centre, Tandojam, Pakistan). pp 69-76 of Rice Breeding With Induced Mutations. II. Vienna; International Atomic Energy Agency (1970).

From 4th Meeting on Rice Breeding with Induced Mutations II, Oiso, Japan. See STI/DOC-10/102; CONF-680848.

Mutagen treatments of the variety Kangni-27 have given rise to short culm and early ripening strains. Experiments have been started with the varieties Dokri Basmati, Jajai-77, Ir-8, and 370 Basmati using fast neutrons, gamma rays, EMS, and diethyl sulfate as mutagens. Results obtained so far show a differential response of the varieties in their radiosensitivity and frequency of leaf color mutations. (auth)

39491 BREEDING FOR EARLINESS, HIGH YIELD, AND DISEASE RESISTANCE IN RICE BY MEANS OF INDUCED MUTATIONS. Haq, M. S.; Ali, S. M.; Maniruzzaman, A. F. M. (Atomic Energy Centre, Dacca, Pakistan). pp 77-83 of Rice Breeding With Induced Mutations. II. Vienna; International Atomic Energy Agency (1970).

From 4th Meeting on Rice Breeding with Induced Mutations II, Oiso, Japan. See STI/DOC-10/102; CONF-680848.

Ten varieties of Boro, Aus, and Aman rice were treated with 30 kR of gamma rays from the 500 Ci ^{60}Co source of the Atomic Energy Centre of Dacca. In addition, two rice varieties were treated with EMS and dES. To suppress tillering, the seeds were sown late and at a high seed rate. 300 normal-looking fertile M_1 plants from each variety were harvested at random. The M_2 progenies were sown on a plant-to-row basis to select for high yield, earliness, blast resistance, and response to large doses of nitrogen fertilizer. Characters like plant height, number of tillers, fertile tillers, length of panicle, and time from sowing to maturity were checked. As the results showed great variability in the mutagen-treated material the chances for successful selection are promising. (auth)

39492 INDUCTION AND UTILIZATION OF MUTATIONS IN RICE. Viado, G. B. (Philippine Atomic Energy Commission, Manila); Santos, I. S.; Cada, E.; Escuro, P. B.; Soriano, J. D. pp 85-103 of Rice Breeding With Induced Mutations. II. Vienna; International Atomic Energy Agency (1970).

From 4th Meeting on Rice Breeding with Induced Mutations II, Oiso, Japan. See STI/DOC-10/102; CONF-680848.

Experiments at the Philippine Atomic Research Center with gamma-irradiated seeds of IR-8-288-3 showed a pronounced inhibition of germination at 60 and 70 kR. The LD_{50} was calculated to be about 54 kR at 8 days from seeding. Fertility decreased with increase in gamma radiation dose in an approximately linear fashion. Numerous types of variants have been obtained in the M_2 generation of which the following may be of particular interest: Plant height slightly shorter and leaves darker green, narrower, and more erect than IR-8; 99 days from seeding to harvest, fertile. Plant height distinctly shorter than IR-8, leaves dark green small and stiff, culms small, produced as many as 27 panicle-bearing culms, grains very narrow. Typically IR-8 in early growth but at maturity exhibits long panicle exertion, longer grains than IR-8, 111 days from seeding to harvest, produced as many as 20 productive tillers. At the U. P. College of Agriculture, Los Baños, 308 plants were selected from the M_2 generation of BE-3 and BPI-121, and 85 from the M_3 generation of Bengawan, Peta, and Intan after irradiation with fast neutrons. All these selections were early to medium-early and short to medium-short. More beneficial mutants were obtained with the lower dose treatments of BE-3, BPI-121, and Bengawan and with the higher dose treatments of Peta. Plant-progeny rows of these selections, except those from the photoperiod-sensitive varieties BE-3 and BPI-121, are being grown this 1968 dry season for further evaluation. In the M_4 generation of Peta a larger number of short to medium-short and early to medium-early plants were selected from the 35 to 45 kR gamma treatments and the 0.5 to 1.0% EMS treatments. A total of 2430 plant selections were harvested and are now being grown in plant-progeny rows. Seventy-three uniform lines were selected from the M_3 generation of Peta and Intan irradiated with fast neutrons and from the M_4 generation of Peta treated with gamma rays, mixed radiations, and EMS. All these lines were earlier and mostly shorter than the Peta check. They are now growing in a two-replicate preliminary test with the control. Work at the Maligaya Rice Research and Train-

ing Center has included further selection of mutants in the M_3 of several varieties after different mutagenic treatments, and field tests and observations on 12 indica and 15 japonica mutants. From BPI-121, 140 non-seasonal lines were selected. The range of maturity of the selected lines was 120 to 125 days from sowing to harvesting. From BE-3, 547 lines were selected for non-seasonal characteristics with a range of maturity from 125 to 140 days. Of these selections 12 from BPI-121 and 28 from BE-3 were practically uniform and are now being tested for preliminary yield trials during the 1968 dry season. In the field trials four of the indica mutants gave higher yields than the check. All the indica mutants were non-lodging and relatively early. The japonica mutants did not perform as well as the indica mutants. All were non-lodging but only the irradiated Taichung 65 Mut. gave a higher yield than BPI-76 (check). (auth)

39493 INDUCTION OF MUTATIONS IN THAI RICE VARIETIES AND SUBSEQUENT SELECTION AND TESTING OF BENEFICIAL MUTANT LINES. Dasananda, S.; Khambanonda, P. (Ministry of Agriculture, Bangkok). pp 105-10 of Rice Breeding With Induced Mutations. II. Vienna; International Atomic Energy Agency (1970).

From 4th Meeting on Rice Breeding with Induced Mutations II, Oiso, Japan. See STI/DOC-10/102; CONF-680848.

Ionizing radiations were first used in the Thailand Rice Breeding Program in 1955 when seeds of two recommended varieties were sent to the United States of America for treatment. As a result, five promising mutant lines are at present in regional yield tests where they are being considered for recommendation to rice growers. During the period 1960 to 1961 an unsuccessful attempt was made to induce resistance to blast in three susceptible varieties by exposing seeds to a local source of ionizing radiation. In 1964, after an elapse of about 4 years, another attempt was made to utilize ionizing radiations in the breeding program by treating seeds of two recommended varieties. In 1965, a coordinated rice mutation breeding program was initiated under the auspices of the Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture which resulted in treating seeds of twelve different rice varieties with both ethyl methane sulphonate and gamma rays from a ^{60}Co gamma cell. The results so far indicate that mutagenic agents were successful in producing genetic variability. Differences in heading date, mature plant height, and plant type are frequently observed in the M_2 and M_3 generations. Several lines obtained from two of the irradiated varieties exhibited a higher degree of resistance to blast than the parental material. From 15-kR treatments of non-glutinous varieties, mutants with glutinous endosperm have been obtained. Not all varieties gave the same response to treatment. (auth)

Health Physics and Safety

Refer also to abstracts 39100, 39425, 39470, and 39614.

Radioactive Contamination and Decontamination

Refer also to abstracts 39451–39453, 39467, 39471, 39472, and 39474.

39494 (A/AC-82/G/L-1319) VALUES OF ^{90}Sr IN VERTEBRAE AND FEMORAL DIAPHYSIS OF ADULTS IN CZECHOSLOVAKIA IN 1969. Brezik, Zdenek; Brezikova, Dagmar (Vyzkumny Ustav Hygieny Zareni, Prague (Czechoslovakia)). [1969]. 7p. Dep. CFSTI (U. S. Sales Only).

Bone samples were collected from 51 adult males and females, aged 25 to 60, who died between September and December, 1969. The ^{90}Sr content of lumbar vertebrae and femoral diaphyses was determined and ratios of the content of vertebrae to that of the femoral bones were calculated. A table is presented to show results. (H.L.W.)

39495 (A/AC-82/G/L-1321) ^{90}Sr CONTENT IN BONES IN CZECHOSLOVAKIA IN 1964–1967. Brezik, Zdenek (Vyzkumny Ustav Hygieny Zareni, Prague (Czechoslovakia)). 8p. Dep. CFSTI (U. S. Sales Only).

The ^{90}Sr content of human vertebrae was determined for 1200 individuals of all ages. The results were divided into 12 age groups and tabulated. A direct relationship to age is shown with a peak in the 6 month to 2 yr groups. The highest content in the younger groups was found in 1964. A decreasing trend was noted in the following years. (H.L.W.)

39496 (CEA-R-3974) USE OF EXTRA-RENAL PURIFICATION METHODS IN THE TREATMENT OF TRITIATED WATER CONTAMINATION. Mirouze, Jacques; Mion, Charles; Fabre, Jean-Luc; Mazaury, Edmond; Henry, Philippe; Mercier, Jacques (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). May 1970. 83p. (In French). Dep. CFSTI (U. S. Sales Only).

After a brief review of the biological and radiotoxicological properties of tritium, methods for the treatment of man following contamination by tritiated water are considered. A method based on extra renal dialysis is described. A study of six cases makes it possible to envisage, for a normal man, a biological treatment period of about 13 hours. Hemodialysis, which was studied in two cases only, should make it possible to reduce this period to less than four hours. In conclusion, a practical method which takes into account the degree of contamination is proposed. (France)

39497 (NP-18220) PUBLIC HEALTH ASPECTS OF THE NATIONAL REACTOR TESTING STATION RADIOACTIVE BURIAL GROUNDS. PART I. LAND BURIAL OF RADIOACTIVE SOLID WASTE. (Bureau of Radiological Health, [Rockville, Md.] Div. of Environmental Radiation). Dec 1969. 20p.

The public health evaluation by the Bureau of Radiological Health of the technical reports, burial techniques, and analysis of the data made available by the Atomic Energy Commission indicated that land burial of solid radiological material at NRTS does not result in a health and safety problem in the off-site area. Further, since no radioactivity was detected off-site that was attributable to this operation, it can be concluded that there is no population exposure and thus, the radiation safety criteria of the Federal Radiation Council were met. Because of the potential long term effects, additional safety measures consistent with a conservative approach regarding radioactivity are required. The following recommendations were made to provide confirmation that long half-life radioactive materials will be confined in the waste disposal ground: each trench and pit should be covered and maintained with a minimum of three feet of soil above the ground level; a minimum of two feet of alluvial soil should be required beneath all buried wastes; flood control measures should be taken to prevent any accumulation of water in the trenches and pits; test holes should be drilled in the vicinity of the burial site to provide detailed information on the lithology and character of the alluvial deposits of underlying basalt; plutonium and americium waste should be segregated in special pits; monitoring should be intensified to provide a positive indication that radioactive material has not migrated from the waste burial ground; and plutonium and americium waste should be accessible for removal from the burial ground should it be detected in the monitoring holes. (auth)

39498 ^{90}Sr IN HUMAN BONES IN THE UNITED STATES, 1962–1966. Baratta, E. J.; Ferri, E. S.; Wall, M. A. (Northeastern Radiological Health Lab., Winchester, Mass.). Radiol. Health Data Rep.; 11: 183-6(Apr 1970).

The Bureau of Radiological Health has been conducting a continuous investigation of strontium-90 in human bones since late 1961. Autopsy specimens, mostly vertebrae, are collected by pathologists, medical examiners, and coroners in selected areas throughout the United States. The population of interest consists of children and young adults up to 25 years of age. Samples were collected from areas around six principal cities: Atlanta, Boston, Cincinnati, Los Angeles, New Orleans, and Seattle. From 1962 through 1966, over 1,600 specimens were analyzed. The specimens are grouped and analyzed according to age and area of residence. A review of the data shows that peak strontium-90 levels occurred in most age groups during the years 1963 and 1964. Decreasing values are shown in analyses for 1966 approaching those of 1962. A histogram of the frequency distribution for 1966 displays a slightly positive skewness which, when plotted, indicates a log normal distribution consistent with earlier observations on biological specimens. (auth)

Dosimetry and Monitoring

Refer also to abstracts 39080, 39210, 39211, 39213, 39216, 39220, 39224, 39226, 39255, 39450, 39455, 39459, 39460, and 39587.

39499 (A/AC-82/G/L-1320) OCCUPATIONAL EXPOSURE TO IONIZING RADIATION IN THE CSSR. Chysky, Jaromir; Trousil, Jaroslav (Institute for Research, Production and Uses of Radioisotopes, Prague (Czechoslovakia)). 18 May 1970. 11p. Dep. CFSTI (U. S. Sales Only).

Measurement of personal exposures of more than one-third of persons employed at work places with sources of ionizing radiation in the CSSR, excepting workers of the Institute of Nuclear Research and workers in the uranium mines, is carried out by the Laboratory of Film Dosimetry, Institute for Research, Production, and Uses of Radioisotopes in Prague. The films applied and the methods of their processing allow the measurement of exposures to γ radiation in the range of 10 mR to 15 to 20 R, x-

ray exposures from 10 mR to 1 R, with the error not exceeding ±20%. The values measured in 1964, 1965, and 1966 are very low on the average. In the years mentioned the yearly exposures did not exceed 500 mR in 82.04%, 84.05%, and 84.16% of the followed-up persons. Only in 0.22%, 0.26%, and 0.72% of the followed-up persons were exposures found exceeding 5 R. Detailed analysis of data obtained in 1966 and the determination of the statistical significance of the differences in the distribution of the yearly exposures of various groups of followed-up persons by means of the Smirnov–Kolmogorov test, disclosed average higher exposures in persons at industrial work places in comparison to medical work places and in medical service in comparison to persons engaged in research. In all basic branches the exposures in men were higher than in women. The magnitude of yearly exposures decreased with the increasing qualification of workers. Exposures in older persons averaged higher than younger persons. At work places with a larger number of persons, the exposures were higher in comparison to work places with a smaller number of persons. In medical service, the highest exposures were at oncological departments, mainly in persons applying ^{226}Ra. In industry the highest exposures are found in work with sealed sources at defectoscopic work places. (auth)

39500 (A/AC-82/G/L-1322) EXPOSURE OF THE POPULATION OF THE CSSR TO IONIZING RADIATION IN X-RAY DIAGNOSTICS. Kunz, Emil; Michal, Vojtech (Vyzkumny Ustav Hygieny Zareni, Prague (Czechoslovakia)). [1966]. 35p. Dep. CFSTI (U. S. Sales Only).

In the period 1958 to 1964, a study was made of gonad doses and exposures on body surface in the primary beam in various x-ray examinations. Data were obtained, characterizing 15 groups of examinations divided in 3 groups according to age and in 2 groups according to sex; these data might give sufficient account of the situation in x-ray practice in the CSSR during this period. This study was continued in 1965 and 1966 by determining the rate of different types of x-ray examinations in various age groups of the population. The data, which may be considered representative for the entire CSSR, indicate that on the average the citizen of this country is x rayed approximately once per year. Of the total, x-ray examinations of lung and heart amounted to practically 60%; they were carried out in more than half the cases within mass radiography of the population groups; the examinations of skeleton and teeth formed 34%. Genetically significant dose from x-ray diagnostics in the CSSR, determined on the basis of the data obtained, amounted in the year 1966 to 37 mR. Nine tables are given. (auth)

39501 (BNWL-1183-4) THE MEASUREMENT OF RADIATION EXPOSURE OF ASTRONAUTS BY RADIOCHEMICAL TECHNIQUES. Quarterly Research Report, January 5, 1970–April 5, 1970. Brodzinski, R. L.; Rancitelli, L. A.; Haller, W. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 15 Apr 1970. Contract AT(45-1)-1830. 27p. Dep. CFSTI.

The urine and feces specimens from the Apollo 12 mission were analyzed for their radionuclide content. Estimates of the cosmic radiation dose received by the astronauts were difficult to determine because of the decay of the short-lived radionuclides during quarantine; however, estimates of the dose to the Apollo 12 astronauts are similar to those received on the Apollo 7 and Apollo 9 missions. The concentrations of ^{7}Be, ^{22}Na, ^{40}K, ^{59}Fe, ^{60}Co, and ^{137}Cs were determined. The radioactivity levels of ^{7}Be, ^{22}Na, and ^{60}Co in both the urine and feces and the levels of ^{40}K and ^{59}Fe in the feces were comparable to those of previous missions. The ^{137}Cs concentration in the feces was lower than in previous missions, while the concentrations of ^{40}K, ^{59}Fe, and ^{137}Cs in the post-flight urine specimens were higher than those observed in previous missions. No ^{147}Pm was observed in any of the samples. The concentrations of seventeen major, minor, and trace elements in fecal samples and eight major, minor, and trace elements in urine samples from the Apollo 11 astronauts were determined. The excretion rates of potassium, rubidium, cobalt, bromine, mercury, antimony, gold, and tin for this mission do not agree with the results from previous missions or normal dietary intakes. An interpretation of these deviations requires a determination of the elemental concentration of the foodstuffs used during these missions. These elemental concentrations should be determined by gross analysis of all food consumed during each mission. A proportional quantity of each food item equivalent to the inventory consumed during a mission should be obtained and an aliquot analyzed for its trace element content by a neutron activation analysis technique. The fecal samples from the Apollo 12 mission were analyzed for their glass fiber content. The observed concentrations and total weights of glass fall within the range of results reported for previous missions. A constant ingestion rate throughout the course of the mission was demonstrated. (auth)

39502 (BRH/DEP-70-9) PRODUCT TESTING AND EVALUATION OF GIANT VIEW TV PROJECTOR. Ruggera, Paul S. (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products). May 1970. 23p. CFSTI.

X-radiation data recorded from the kinescope of a projection television unit are presented. The model tested had a moveable kinescope housing which, when extended, essentially removed the shielding effect of the cabinet. Measurements were made under typical operating conditions, and these were related to the two extremes of kinescope position. In addition, a leaded kinescope of the same type was substituted, and data showing the relationship between the lead content of the glass envelope and the emission rate are reported. (auth)

39503 (LIB/Trans-279) UTILIZATION OF THE INDEX OF CHROMOSOME ABERRATIONS FOR BIOLOGICAL DOSIMETRY. Vander Elst, E.; Gimenez, J. C.; Beninson, D. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). Translated by G. M. Watson (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from report SI-1. 15p. Dep. CFSTI (U. S. Sales Only).

Determination of chromosome aberrations in peripheral blood allows estimation of the mean dose and correspondingly valuable information on the degree of inhomogeneity of the irradiation. The relationship is $F = a + BD$ where (F) is fraction of deletions per cell for a dosage (D) in rads, (a) is spontaneous deletion frequency and (b) is coefficient of production of radio-induced aberrations. Similarly $F^{1} = c + dD^{2}$ where F is the fraction of rings and dicentrics observed per cell. Determination of the indices of irradiation in the bone marrow can have practical applications in cases of irradiation of the parts of the organism in which it may be important to know the dose received locally in that tissue. (Australia)

39504 (ORNL-4446, pp 225-41) DOSIMETRY FOR HUMAN EXPOSURES AND RADIOBIOLOGY. Auxier, J. A.; Cheka, J. S.; Fox, W. F.; (and others) (Oak Ridge National Lab., Tenn.).

Calculation and estimation of the γ and neutron dose to the human populations of Hiroshima and Nagasaki continue. Attempts to improve the calculations for RBE of neutrons for prompt effects, epilation, and leukemia were made by excluding survivors receiving less than 50 or more than 300 rads. An RBE of 5 seemed to correlate the number of leukemia cases to dose better than the previous integral values of RBE. A ^{252}Cf source was used in experiments designed to determine the γ and neutron leakage from weapons similar to those exploded over Hiroshima and Nagasaki. The variations in leakage factors for the two weapons can be accounted for by the difference in the shielding materials used for the two weapons. Depth dose and LET distributions were calculated for neutrons from a broad parallel beam incident on the side of a cylindrical phantom. Calculations were also made for recoil ions and neutron-produced γ rays for separate neutron energies of 0.025 eV and 1, 2.5, 5, 7, and 14 MeV. LET spectra were computed for 2.5 and 14 MeV neutrons. Other radiobiological studies included: dosimetry for ^{252}Cf sources; dose distributions in cylinders exposed during operation HENRE; ^{24}Na determinations in swine exposed to 14 MeV neutrons; and thermal-neutron distributions from a point source of 14 MeV neutrons. (E.R.B.)

39505 (ORNL-4446, pp 279-98) INTERNAL DOSE ESTIMATION. (Oak Ridge National Lab., Tenn.).

A compartmental model for the kinetics of Fe metabolism in man was developed for use in calculations of the internal radiation dose following intravenous administration of ^{55}Fe or ^{59}Fe. Decay scheme data are presented and methods used to calculate the absorbed fractions of photon energy in erythrocytes and whole-body tissues during the decay of ^{55}Fe and ^{59}Fe in relation to body weight and radioisotope residence time are described. Methods used to estimate the radiation dose to bones and other tissues of dogs and man following the parenteral administration of ^{232}Th and decay to ^{228}Ra, based on microcurie-days residence in organs and tissues and a biological model of tissue distribution and excretion, are described. The use of urinary excretion data to estimate the body burden of ^{239}Pu in man and to evaluate the possibility of a new intake is discussed. (C.H.)

39506 (ORNL-TM-2991) CALCULATION OF NEUTRON-INDUCED PHYSICAL DOSES IN HUMAN TISSUES. Ritts, J. J.; Solomito, M.; Stevens, P. N. (Oak Ridge National Lab., Tenn.). 22 May 1970. Contract W-7405-eng-26. 104p. Dep. CFSTI.

Improved multicollision neutron fluence-to-dose conversion factors were calculated by solving the combined neutron and γ-ray transport problems in phantom models designed to represent human beings. Also, new neutron fluence-to-kerma factors and improved secondary γ-ray yields were determined for the elements composing the slabs. The neutron and γ-ray cross-section data used in the calculation came primarily from ENDF/B and the OGRE Library, respectively. The computer code ANISN

was employed in solution of the transport equation. The neutron fluence-to-kerma factors calculated herein agree very well with previous work. The results are presented for the 11 most common elements in the standard man. Multicollision neutron fluence-to-dose conversion factors were calculated for neutron sources, either beams or isotropic fluxes of energies from 15 MeV to thermal, incident on a 30 cm slab with infinite or finite transverse dimensions. The curves representing the total of the neutron and γ-ray energy deposition were found to range from approximately 6% to a factor of two lower than those previously reported. This effect is attributed primarily to the treatment of secondary γ rays and becomes more pronounced with increasing depth. Results are presented for 38 different combinations of source and geometry and for the maximums as a function of the source energy for each set of calculations. (auth)

39507 (SWRHL-95-r) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR THE MILROW EVENT, OCTOBER 2, 1969. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Jun 1970. 22p. Dep. CFSTI.

Amchitka Island, a member of the Rat Island group in the Aleutian Islands, was first used for an underground nuclear test on October 29, 1965, by the Department of Defense. A second underground test, called the Milrow Event, was conducted by the Atomic Energy Commission at Amchitka on October 2, 1969. The operational procedures and results of the Public Health Service, Southwestern Radiological Health Laboratory off-site radiological safety and community information programs provided for Milrow are presented. The off-site radiological safety program included operating environmental surveillance networks of air samplers, thermoluminescent dosimeters and gamma-rate recorders before and after the detonation, and fielding 13 radiation monitors for the detonation. All surveillance and monitoring results indicated no increase in radioactivity above background levels in the off-site area following the event. The community information program consisted of contacts with residents and local officials at various communities in Alaska to discuss the Milrow Event and off-site radiological safety program. A concentrated information program was conducted at Adak, Shemya, and St. Paul to answer questions regarding Milrow Event effects at those locations. (auth)

Radiation Protection

39508 (BNWL-MA-7) PROCEDURES FOR RADIATION MONITORING. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 1 Feb 1968. 120p. Dep. CFSTI.

The organization and functions of the radiation protection program at Battelle-Northwest are reviewed. Topics discussed include: the establishment of radiation zones; methods for the control of external and internal exposure of personnel; the use of protective equipment and apparel; the control of tritium exposure; procedures for handling radiation accidents; methods used for monitoring equipment, work areas, off-site areas, and personnel; methods used for handling and shipping radioactive materials; methods used for the decontamination of personnel; the calibration and testing of radiation monitors; emergency monitoring and rescue procedures for criticality and non-criticality accidents; procedures used for reporting radiation accidents; and training programs for personnel. (C.H.)

39509 SOME APPROACHES TO THE SUBSTANTIATION OF THE PERMISSIBLE DOSES FOR COSMONAUTS DURING PROLONGED SPACE FLIGHTS. Grigor'ev, Yu. G.; Raevskaya, S. A.; Avrunina, G. A.; Farber, Yu. V.; Gorlov, V. G. Radiobiologiya; 10: 294-9(Mar-Apr 1970).

Specifics of the radiation environment in space and the peculiarities of the approach to standardization of the levels of radiation influence for spaceship crews are discussed. The criteria of radiation safety for cosmonauts during prolonged space flights are formulated. It is proposed that the concept of the dose equivalent, recommended by the International Commission for Radiation Protection, be used to evaluate the hazards of radiation in space, which is complex in composition and nature of influence. The available literature data for evaluating the dose equivalent (DE) are discussed, and examples of calculation of the effective dose needed for this are cited. (auth)

Safety Procedures

39510 (NP-18246) A GUIDE FOR UNIFORM INDUSTRIAL HYGIENE CODES OR REGULATIONS FOR LASER INSTALLATIONS. Supplement No. 7. Berghout, C. Fred; Burgess, Dale E.; Burk, Chapman; Jensen, Carl; Knauber, John W.; Palmisano, William; Sprague III, George F. (American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio). 1968. 22p.

Certain health hazards common to all types of lasers are reviewed. Minimum guidelines are presented to ensure the health and safety of industrial personnel in the laser control area and other persons likely to be exposed to laser radiations. (C.H.)

39511 (RT/PROT-(70)7) ON THE RADIATION AVERAGE DOSE ABSORBED BY TRUCK DRIVERS IN ITALY (1967-1968). Faloci, C.; Susanna, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 10 Apr 1970. 40p. (CONF-690929-2). Dep. CFSTI (U. S. Sales Only).

From 15th National Congress of the Italian Association for Health Physics and Protection against Radiation, Cagliari, Italy.

A study was conducted for the purpose of estimating the average dose absorbed by truck drivers in the years 1967 to 1968. In the course of the study a statistical survey was made also on the shipments of radioactive materials that took place in Italy in the said period, and the distribution frequency for the radionuclides most commonly used for therapeutical, diagnostic, industrial, and research purposes was determined. In conducting the survey, constant attention was given to identifying the protection problems connected with the shipping activities. (14 Figures; 5 Tables) (auth)

Civil Defense

39512 (NP-18298) CIVIL DEFENCE: AN ANNOTATED BIBLIOGRAPHY, 1960-1968. Malwad, N. M. (comp.) (Bhabha Atomic Research Centre, Bombay (India)). Jan 1970. 244p. Dep. CFSTI (U. S. Sales Only).

The bibliography consists of 383 references to bibliographies, reports, journal articles, books, and conferences on civil defense. The bibliography includes documents on defense against nuclear war, its effects on men and materials, preparations needed to face nuclear war such as construction of shelters, medical problems, food storage and supply, sanitation, ventilation, and possible recovery after the nuclear war. An abstract is provided with each reference. (H.L.W.)

Legal Aspects

Refer also to abstract 39584.

39513 (EUR-4466) ANALYSIS OF THE INTERNATIONAL LEGAL AND ADMINISTRATIVE REGULATIONS ON FOOD IRRADIATION WITH REGARD TO THE PUBLIC HEALTH ASPECTS. Cornelis, J. Ch. 1970. 39p. Dep. CFSTI (U. S. Sales Only). FF 5.60.

Scientific data on food irradiation are considered from the legal and administrative point of view. Existing legislation is summarised and analyzed with special attention to procedures for obtaining clearance for consumption of radiation processed foods. The need for international cooperation on several important legal and administrative questions is stressed. The possible role of several international organisations is discussed. A first draft for international regulations is included. (auth)

39514 (JPRS-50347) TRANSLATIONS ON EASTERN EUROPE. Scientific Affairs No. 19. 29p. CFSTI.

Three papers discuss the organization and functions of the Hungarian Academy of Sciences and one paper discusses the operation of the EWA experimental reactor at Swierk, Poland. A separate abstract was prepared for one paper. (C.H.)

For an abstract of one paper see: 39515.

39515 (JPRS-50347, pp 21-9) DECREE ISSUED ON STATE COMMITTEE FOR NUCLEAR ENERGY. Translated from Bul. Of. Repub. Soc. Rom.; No. 2, 8-10(30 Jan 1970).

The provisions of the 1969 decree concerning the organization and operation of the state committee for Nuclear Energy in Romania are outlined. (C.H.)

Medicine

Refer also to abstracts 38783, 39162, 39412, and 39425.

Protective Substances

Refer also to abstracts 39484-39487, 39490-39492, and 39564.

39516 (COO-1223-15) HYPOXIA AND PARA-AMINOPROPIOPHENONE AS RADIOPROTECTIVE AGENTS. Final Report. Bonner, John F. Jr. (Indiana Univ., Indianapolis. Dept. of Biochemistry). 25 May 1970. Contract AT(11-1)-1223. 9p. Dep. CFSTI.

Reaction mechanisms involved in the radioprotective effects of hypoxia and p-aminopropiophenone (PAPP) were investigated in mice. High pressure oxygen was found to increase the sensitivity of mice to x rays. Methemoglobin producing drugs, antioxidants, and sulfhydryl compounds did not increase the survival of mice exposed to five atmospheres of oxygen. High partial pressures of CO_2 provide a measurable radioprotective effect in mice. N-hydroxy-p-aminopropiophenone appeared to be the metabolite of PAPP responsible for the production of methemoglobinemia in experimental animals. The metabolism of PAPP was found to be complex; seven compounds were identified and at least two remain to be identified in mouse urine. Benzhydrazide prevented the production of methemoglobin by PAPP both in vivo and in vitro, presumably by blocking the N-hydroxylating enzymatic pathway. (auth)

39517 (COO-2055-2) GRAFT VERSUS HOST INHIBITION. III. FETAL THYMIC FACTOR AND FETAL LIVER CELLS TO MINIMIZE SECONDARY DISEASE. Bortin, Mortimer M.; Rimm, Alfred A. (Mount Sinai Hospital, Milwaukee, Wis. May and Sigmund Winter Research Lab. Marquette School of Medicine, Inc., Milwaukee, Wis.). [1969]. 25p. Dep. CFSTI.

Lethally irradiated CBA host mice were given I-V injections of perinatal liver hematopoietic cells from strain-A donors. Survival studies demonstrated that 57% of the hosts were alive at 100 days when treated with fetal liver cells and 50% survived 100 days when treated with liver cells from 5-day-old mice. All lethally irradiated CBA mice survived 100 days when protected with strain-A fetal liver cells I-V plus I-P Millipore chambers containing thymus cell suspensions from strain-A fetal donors. This salutary effect on survival, over that observed with liver cells alone, was highly significant ($P < 0.001$). This beneficial effect on survival was eliminated when the Millipore chambers containing fetal thymus tissue were first stored 8 to 10 days in temporary syngeneic hosts. The addition of thymus tissue in Millipore chambers from strain-A 5-day-old donors did not significantly alter survival from that observed when only liver cells were given. It was concluded that the strain-A fetal liver-thymus combinations acted synergistically to enhance survival of the CBA mice. This effect was probably due to a subcellular factor from the fetal thymus which acted on the liver cells. It was noteworthy that the subcellular factor was apparently present only in the fetal thymic tissue. Secondary disease was at a minimum as evidenced by the excellent long-term survival, healthy and vigorous appearance of the mice, absence of overt graft versus host disease, and absence of overt infection. (auth)

39518 (JPRS-50859) RADIOPROTECTIVE ACTION OF SOME ANTIOXIDANTS OBTAINED FROM PETROLEUM PRODUCTS. Karaev, A. I.; Gasanov, G. I.; (and others). Translated from Biol. Nauki; No. 5, 47-55(1970). 13p. CFSTI.

Using physicochemical methods, it was shown that certain physiologically active substances synthesized from petroleum by-products are antioxidants and that they have radioprotective action. Tests were made on x-irradiated rats. (C.O.)

39519 (NP-18175) EFFECT OF X, GAMMA, AND UV RADIATIONS ON POPULATIONS OF DUGESIA DOROTOCEPHALA (PLATYHELMINTHES:TURBELLARIA) UNDER ACTION OF THE SEROTONIN-SULFATE COMPLEX OF CREATININE. Laguarda-Figueras, Alfredo (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1969. 98p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

Thesis.

The radioprotective effects of the serotonin-sulfate complex of creatinine against the effects of x and γ were shown by a statistical analysis of the dose-mortality variables for planaria. The importance of the time factor with respect to mortality found in animals irradiated with and without treatment was studied for both radiations. The pretreatment of the planaria did not protect them against the effect of x rays. The effects of uv radiation on the planaria (Dugesia dorotocephala) and the ineffectiveness of the creatinine complex in protection against the radiation was also studied. (tr-auth)

39520 PROBLEM OF DIFFERENTIATED CHANGE IN THE RADIOSENSITIVITY OF NORMAL AND TUMOR CELLS. Yarmenko, S. P.; Pelevina, I. I. (Inst. of Experimental and Clinical Oncology, Moscow. Inst. of Chemical Physics, Moscow). Radiobiologiya; 10: 188-97(Mar-Apr 1970).

The possibility of changing the radiosensitivity of tumor and normal cells in order to increase the effectiveness of radiation therapy of tumors by selective protection of normal tissues or by predominant radiosensitization of tumor cells is discussed. The basic methods and classes of substances, the use of which can lead to a directed change in the radiosensitivity, are also discussed. (auth)

39521 MECHANISM OF THE RADIOSENSITIZING EFFECT. Tarasenko, A. G.; Nekrasova, N. V.; Graevskii, E. Ya. (Inst. of Developmental Biology, Moscow). Radiobiologiya; 10: 198-211(Mar-Apr 1970).

The mechanism of the radiosensitizing action of most of the radiosensitizers now known, belonging to the most varied classes of chemical compounds, is considered from the standpoint of the sulfhydryl hypothesis. It is concluded that the overwhelming majority of the sensitizers increase the radiosensitivity of biological objects as a result of blocking of the intracellular thiols before irradiation. The action of sensitizers incapable of reacting directly with thiols is considered from this standpoint, and it is noted that the increase in the radiosensitivity under their influence is also associated through biological mechanisms with the change in the thiol level. (auth)

39522 SOME PROBLEMS OF RADIOPROTECTION. Konstantinova, M. m.; Zherebchenko, P. G. (Inst. of Developmental Biology, Moscow. Inst. of Biophysics, Moscow). Radiobiologiya; 10: 230-41(Mar-Apr 1970).

The modern concepts of the mechanisms of radioprotective effects are discussed, and possible ways of synthesizing new classes of radioprotectors are considered. In addition, possibilities of increasing the effectiveness of already known radioprotectors, in particular, by eliminating the toxicity of compounds, are discussed. This is achieved either as a result of a change in their chemical structure or by using them together with substances that compensate for the toxic influence. (auth)

39523 INFLUENCE OF THE PROPHYLACTIC ADMINISTRATION OF CYSTAMINE ON THE BIOELECTRIC ACTIVITY OF CERTAIN PORTIONS OF THE BRAIN. Diner, L. D.; Mozzhukhin, A. S. (Military-Medical Academy, Leningrad). Radiobiologiya; 10: 289-93(Mar-Apr 1970).

The effect of prophylactic administration of cystamine at a dose of 100 mg/kg on the change in the bioelectric activity of the reticular formation of the midbrain, the nuclei of the anterior and posterior hypothalamus, and the sensomotor region of the cerebral cortex of cats subjected to whole-body x irradiation at a dose of 600 R was studied. The prophylactic administration of cystamine substantially reduced the degree of expression of the changes in the bioelectric activity in all the regions studied, with the exception of the reticular formation of the midbrain. (auth)

39524 PROTECTIVE ACTION OF CERTAIN SULFUR-CONTAINING COMPOUNDS AGAINST RADIATION INJURY IN SEEDLINGS OF VICIA FABA. Avakyan, Ts. M.; Semerdzhyan, S. P.; Esayan, G. T.; Oganesyan, Dzh. O. Biol. Zh. Arm.; 21: No. 8, 12-17(1968). (In Russian).

The experiments were conducted on three-day-old seedlings of Vicia faba. The radioprotective properties of 5 compounds were studied: the hydroiodic salt of 2,6-diamidodihydro-1,3,5-dithiazone (MT), the hydrochloride salt of isothiourea (TG-1), S-(3-nitro-4-oxybenzene) sodium thiosulfate (TG-2), S-(3-nitro-4-methoxybenzene) isothiourea (TG-3), and S-(3-nitro-4-methoxybenzene) sodium thiosulfate (TG-4). The sulfur-containing compounds were separated into two groups: TG-1, TG-2, and TG-2-3, having a radioprotective effect or reducing the level of radiation injury, and MT and TG-4 that sensitized the seedlings to x rays. (auth-tr)

Radiodiagnosis

Refer also to abstracts 39141, 39208, 39212, 39220, 39223, 39228, 39243, 39244, 39257, 39271, 39273, 39274, 39278, 39415, 39417, and 39500.

39525 (NP-tr-1903) DIAGNOSIS OF MALIGNANT TUMORS WITH A p.i.n TYPE SEMICONDUCTOR DETECTOR. Higashi, T.; Ikemoto, S.; Suzuki, S.; (and others). Translated by S. G. Brickley (Atomic Energy Research Establishment, Harwell, Eng.), from Radioisotopes (Tokyo); 17: 311-15(1968). 13p. Dep. CFSTI (U. S. Sales Only).

The semiconductor has recently come into prominence as a new radiation measuring device. It has many special characteristics not found in other types of radiation detector, its most advantageous points being its robustness, its small size, and its safety, which latter arises from its low working voltage. However, medical use of this detector is, at the present time, restricted to employment in certain research institutes. Attempts were made to manufacture a catheter form p•i•n type semiconductor detector and to apply it to examinations of cancers of the oesophagus, uterus, and rectum. The detector was introduced into bodily apertures 24 hours after intravenous injection of approximately 250μCi of ^{32}P had been given and determinations made of ^{32}P intake. ^{32}P intakes being clearly higher in areas of cancerous tissue, the instrument was useful also in the ascertaining of limits of cancer permeation. (auth)

39526 (ORAU-110, pp 81-129) RESEARCH IN NUCLEAR MEDICINE. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Radioisotope scanning techniques, using ^{67}Ga as the tracer, for the diagnosis and localization of neoplasms were investigated in animals and man. Scanning techniques for the differential diagnosis of primary or idiopathic myelofibrosis in man were investigated. Thyroid and whole-body uptake and retention of ^{131}I as a measure of thyroid function in man were compared. The computer processing of data from radiobiological studies is discussed. (C.H.)

39527 (PRNC-135, pp 224-32) MEDICAL USES OF SHORT HALF-LIFE RADIONUCLIDES IN LATIN AMERICA. Touya, E. F.; Touya, J. J. (Universidad de la Republica, Montevideo (Uruguay). Centro de Medicina Nuclear). (In Spanish).

From Radiation and isotope technology in Latin American development.

Comparisons are made between metabolic and scanning examinations made with portable and fixed detectors, carried out using ^{131}I, ^{198}Au, ^{51}Cr, ^{59}Fe, ^{203}Hg, and ^{85}Sr, considered as long half-life radionuclides, and these examinations made with ^{99m}Tc, ^{113m}In, ^{87m}Sr, and ^{197}Hg, considered as short half-life radionuclides on approximately 2,000 patients. The future direction of nuclear medicine in Latin America is discussed. (auth)

39528 (PRNC-135, pp 253-60) TECHNETIUM-99m: AN INEXPENSIVE ROUTE TO A VERSATILE RADIOISOTOPE. Richards, P. (Brookhaven National Lab., Upton, N. Y.).

From Radiation and isotope technology in Latin American development.

The use of short-lived isotopes in medical diagnostic procedures is one of the areas showing the most rapid growth in the use of radioisotopes today. It is also a field in which many nuclear centers can make valuable contributions to their communities. Two short-lived radionuclides, ^{18}F and ^{99m}Tc, in the form of various labeled pharmaceuticals are useful in most of today's clinical procedures. Both of these nuclides can be produced in reactors available to medical centers. A solvent extraction technique has been developed that makes possible the separation of the high quality ^{99m}Tc from low-specific activity parent ^{99}Mo. The development of a close working arrangement between nuclear and medical centers can result in a modern nuclear medicine program using these nuclides which can be carried out with a maximum degree of efficiency. (auth)

39529 (UCLA-12-777) UNILATERAL PULMONARY ARTERY AGENESIS, STENOSIS AND HYPOPLASIA. FUNCTIONAL DISTURBANCES REVEALED BY RADIOISOTOPE LUNG IMAGING. Isawa, Toyoharu, Taplin, George V. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1969]. Contract AT-04-1-GEN-12. 28p. Dep. CFSTI.

Two patients with pulmonary artery agenesis, one with stenosis and another with hypoplasia, were studied by three types of lung scintigraphy, including ^{133}Xe inhalation, ^{99m}Tc or ^{113m}In aerosol inhalation, and ^{99m}Tc or ^{131}I-MAA perfusion. In pulmonary artery agenesis, perfusion is completely absent and ventilation to the affected lung is reduced but with no evidence of airway obstruction. In pulmonary artery stenosis, perfusion is greatly diminished but ventilation is normal in the affected lung. In pulmonary artery hypoplasia perfusion and ventilation are both diminished, but there are signs of severe airway obstruction in the affected lung. In stenosis and hypoplasia, perfusion to the involved lung can be increased by placing the affected lung in the most dependent position. Differential scan features of these vascular anomalies versus pulmonary embolism and bronchogenic carcinoma are discussed. Lung scintigraphy not only enables regional functional disturbances to be visualized but also reveals specific abnormalities of ventilation and perfusion from which diagnoses of these pulmonary artery anomalies can be facilitated. (auth)

39530 (UCLA-34-P-119-25) CLINICAL APPLICATIONS OF A HIGH QUANTUM UTILIZATION SCANNER. Annual Progress Report, 1969-70. (California Univ., Los Angeles). Contract AT(11-1)-34. 10p. Dep. CFSTI.

The performance of a high-resolution fast-section scanner for tomographic visualization of brain lesions following administration of ^{99m}Tc-pertechnetate was evaluated. The section scan was found to be a useful supplement to conventional scans for the detection and localization of both malignant and non-malignant brain tumors and other cranial lesions. Results of scans on approximately 60 patients are reported. Other tracer compounds for use in brain scanning were investigated and results are reported from studies on the toxicity of ^{51}Cr-chelates in mice and the uptake of ^{125}I HSH in cultured human astrocytoma cells. (C.H.)

39531 BEHAVIOR OF ^{99m}Tc AND ^{131}I IN THE STOMACH. Fridrich, R.; Meier-Ruge, W.; Engelhart, G. (Buergerspital, Basel. Univ., Basel). Klin. Wochensch.; 48: 174-9(1 Feb 1970). (In German).

Technetium-99 and ^{131}I behave differently in the stomach. Whereas the accumulation and secretion of the two radioisotopes are similar, their distribution differs. Radiotechnetium deposits in the area of the parietal cells, radioiodine in that of chief and mucosal cells. The distribution of radioiodine is uniform whereas that of radiotechnetium is lower in the gastric antrum. The uptake, turnover, and output of both substances are different in individuals. There seems to be a relationship with the gastric juice production. Therefore, in contrast to neoplasms, the inflammatory process is not visible on the scan. A cold area is hence reflective of a neoplastic process. The scintiscanning of the stomach with ^{99m}Tc or ^{131}I is an appropriate method to differentiate between inflammatory and neoplastic processes. The exposure with ^{99m}Tc is lower than that with ^{131}I and is therefore preferable. (auth)

39532 CONTRIBUTION OF RADIOLOGY TO THE DIAGNOSIS OF CEREBROVASCULAR ACCIDENTS. CLINICAL RADIOLOGICAL CONFERENCE, DECEMBER 1968, BASEL. Hartweg, H. (Buergerspitals, Basel). Schweiz. Med. Wochensch.; 100: 909-17(23 May 1970). (In German).

Diagnosis of cerebrovascular insults is discussed on the basis of clinical findings, angiography, ultrasound, and ^{99m}Tc pertechnetate. Differential diagnosis between tumors and vascular disturbances can be established by periodic scintigrams. Within the first two weeks after a cerebrovascular accident, a relatively large area of increased activity is found with irregular borders and inhomogeneities. However, at that time, only 40% of the patients show positive scintigraphic findings. Repetition of scanning three to four weeks following the accident is positive in more than 70% of the patients. As time goes on, the area of activity becomes smaller in size and, between two to six months, disappears entirely. Tumors show an entirely different behavior by remaining either constant or growing in size. Since cerebral scans are not specific enough, angiography is required before surgical intervention. (H.B.G.)

39533 SCINTILLATION CAMERA RENOGRAPHY IN THE IDENTIFICATION OF AN UNCOMMON RENAL TRANSPLANT COMPLICATION. Wilkinson, Robert H. Jr.; Goodrich, Jack K. (Duke Univ., Durham, N. C.). J. Urol.; 104: 36-40(Jul 1970).

A case report is presented to illustrate the value of the Anger scintillation camera with renographic capability in the evaluation of renal transplant complications. In the case reported the combined renogram curve and renal scintiphotographs demonstrated post-renal transplant urine extravasation. This combined study may be considered an extension of the conventional renogram in evaluation of renal transplant function. (auth)

39534 RENAL ISOTOPE CLEARANCE BY EXTERNAL MONITORING AND FEEDBACK TECHNIQUE. A NEW CATHETER-FREE CLEARANCE METHOD. Christiansen, N.; Hansen, H.; Madsen, P. O. (Veterans Administration Hospital, Madison, Wis. Univ. of Wisconsin, Madison). J. Urol.; 104: 26-35(Jul 1970).

A new catheter-free kidney clearance technique using external monitoring of radioisotopes over the patient's head has been developed. The principle of the new technique is to measure the amount of a given substance labeled with a radioisotope and infused intravenously so as to keep the plasma concentration of the tracer substance constant. This substance should ideally be excreted by the kidneys exclusively. The equipment and technique for this new method are described in detail. The effective renal plasma flow (ERPF) was evaluated by this method using ^{131}I Diodrast. Sixteen clearance experiments were carried out in 10 patients whose renal function varied from poor to normal. The clearance according to this new method correlated well with clearance obtained simultaneously by conventional clearance techniques. When this technique is used a catheter is not necessary for urine collection, it is more accurate than the single injection technique and changes in renal function will be detected within a few minutes. If collection of urine is difficult or delayed, as in hydronephrosis or when the urine volume is low, this method still gives an accurate estimate of renal function. It should be possible to monitor glomerular filtration and ERPF simultaneously if the respective substances used for these clearances could be tagged with the proper isotopes. The method could possibly also be made suitable for liver function testing. Because of this new method's definite advantages over the presently available clearance techniques it may be expected to become the preferred clearance method in centers in which isotope equipment is available. (auth)

39535 SUPERSELECTIVE ARTERIAL CATHETERIZATION OF TUMORS OF THE UROGENITAL TRACT: A MODALITY USED FOR PERFUSION WITH CHEMOTHERAPEUTIC AGENTS

AND INFARCTION WITH RADIOACTIVE PELLETS. Lang, Erich K. (Louisiana State Univ., Shreveport). J. Urol.; 104: 16-25(Jul 1970).

Superselective arteriography of renal tumors is advocated for exact staging of the tumor and as a vehicle for selective delivery of chemotherapeutic agents and infarct implant of radioactive material to the tumor. The propensity of such an infarct implant to limit radiation almost exclusively to the tumor permits an increase of total radiation dose to about 5000 rep. The combination of preoperative irradiation delivered by the infarct implant and localized chemotherapy appears to substantially decrease the size of the tumor, decrease the chance of implantation of viable tumor cells during surgical manipulation, and facilitate the resection of tumors once considered inoperable. The technical ease and safety of this procedure are emphasized. The modality is advocated as an important adjunct to radical surgery in the management of hypernephroma. Analysis of initial survival statistics appears to bear out the value of this combined therapeutic approach. (auth)

39536 SYMPOSIUM ON NUCLEAR MEDICINE IN INTERNAL MEDICINE. 3. APPLICATION OF RADIOISOTOPES TO THE DIAGNOSIS OF ANEMIAS. Wakisaka, Gyoichi (Kyoto Univ.). Jap. J. Med.; 8: 208-10(Jul 1969).

The uses of radioisotopes in the diagnosis and elucidation of the pathogenesis of various anemias are described on the basis of laboratory experiences. A new analytical method for the study of intestinal iron absorption by simultaneous use of ^{59}Fe and ^{55}Fe indicated the two phases of absorption, namely the rapid phase and slow phase and that the former significantly increases in patients with iron deficiency anemia. Chondroitin sulfate iron labeled with ^{59}Fe and ^{55}Fe globulinate was used in the studies of iron metabolism in the reticuloendothelial system. The red cell life span in various anemias was determined by the simultaneous uee of ^{51}Cr and DF ^{32}P. The result indicated the reduced elution rate of ^{51}Cr in iron deficiency anemia. The hemodynamic pattern of the spleen was studied by analyzing the splenic uptake and dilution curves of red cell radioactivity in the peripheral blood following intravenous administration of ^{51}Cr-labeled red cells. The studies of absorption and metabolism of vitamin B_{12} using radioactive B_{12} proved to be useful for the diagnosis and study of the pathogenesis of megaloblastic anemia. The B_{12} absorption test using a whole-body counter in sliding method proved to have many advantages over the conventional methods in simplicity and accuracy. The absorption test of folic acid using ^{3}H-FA was found to be important for the diagnosis of megaloblastic anemia due to folic acid deficiency. (NSA of Japan)

Radiotherapy

Refer also to abstracts 39120, 39553, 39581, 39582, and 40606.

39537 (IN-1317, pp 209-31) TECHNIQUE DEVELOPMENT FOR PHYSICAL AND BIOLOGICAL SCIENCES. (Idaho Nuclear Corp., Idaho Falls).

Progress is reported on plutonium detection in bone sections; biomedical research in the 25 keV beam; biomedical research in the 2 keV beam; examination of zinc phosphate dental cements by neutron diffraction; activation analysis of geological samples; filtered beams as a neutron source for seed irradiation studies; activation analysis of biological tissue; neutron activation method for investigating questionable archaeological specimens; and neutron molecular spectra of glycine. (H.L.W.)

39538 (NP-tr-1909) INTRALYMPHATIC RADIOISOTOPE THERAPY WITH ^{32}P-LECITHIN-ETHIODOL. Yamamoto, Y.; Yamamoto, S.; Tachibana, A.; Yoshikawa, S. Translated by R. A. Scutt (Atomic Energy Research Establishment, Harwell, Eng.), from Radioisotopes (Tokyo); 16: 449-53(1967). 11p. Dep. CFSTI (U. S. Sales Only).

^{32}P-lecithin was biosynthesized in rabbit, and purified by a cadmium-precipitation method. ^{32}P-lecithin was dissolved with Ethiodol, and administered in the lymphatic canal of cancer patients. This was turbid by mixing with body fluids as colloidal state, was taken up in lymph nodes, and ^{32}P penetrated in the metastatic part of cancer. That was readily recognized on the macro- and micro-autoradiogram. Intralymphatic radioisotope therapy should wield the power for cellular metastasis that might remain following lymph node removal by radical operation. (auth)

39539 (ORAU-110) MEDICAL DIVISION RESEARCH REPORT FOR THE YEAR ENDING DECEMBER 31, 1969. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.). 207p. Dep. CFSTI.

Separate abstracts were prepared on two sections of this report. Brief summaries of published papers and a list of 113 publications during the period covered by this report are included. (C.H.)

For abstracts of individual sections see: 39526 and 39540.

39540 (ORAU-110, pp 5-80) RADIATION EFFECTS AND RELATED TOPICS. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

The clinical response of patients with myeloproliferative disorders, either primary thrombocytosis, polycythemia vero, or chronic granulocytic leukemia, treated by residence times varying from 73 to 208 hrs in a low exposure rate whole-body γ irradiation facility is reported. Data are tabulated on the total leukocyte count, platelet count, and gastrointestinal tract following exposure to total doses ranging from 59 to 148 rads. The effect of dose rate on the biological response is discussed. Related studies reported include the identification of microorganisms (bacteria and yeast) of irradiated patients; studies of the radiation dose received by various organs in the patients using tissue-equivalent phantoms; and related radiobiological studies using experimental animals. (C.H.)

39541 LATE SEQUELAE AFTER RADIOIODINE SUPPRESSION OF HYPERTHYROIDISM. Haffner, B.; Frischauf, H. (Medizinische Univ., Vienna). Wien. Klin. Wochenschr.; 82: 272-5(10 Apr 1970). (In German).

From January 1959 to December 1968, 223 hyperthyroid patients were treated with ^{131}I. In 192 cases, or 86%, euthyroid state was obtained; 14 patients, or 6.3% became hypothyroid; and 17 patients, or 7.6%, returned to a hypothyroid state requiring additional iodine therapy. A clear correlation could not be established between occurrence of complications and radioiodine dose, size of thyroid gland, clinical findings, and laboratory data. (tr-auth)

39542 IRRADIATION AND 5-FLUOROURACIL AS ADJUVANTS IN THE MANAGEMENT OF INVASIVE BLADDER CARCINOMA. A COOPERATIVE GROUP REPORT AFTER 4 YEARS. Prout, George R. Jr.; Slack, Nelson H.; Bross, Irwin D. J. (Massachusetts General Hospital, Boston. Roswell Park Memorial Inst., Buffalo). J. Urol.; 104: 116-29(Jul 1970).

The current status of patients in a cooperative study evaluating the effect of preoperative irradiation and postoperative 5-fluorouracil (5-FU) on patients with invasive bladder carcinoma is described. Within a 4-year period 325 patients were studied. Preoperative radiation dose used was 4,500 R in 28 to 32 days. (C.H.)

39543 TREATMENT OF CARCINOMA OF THE ORAL CAVITY. Benak, Steve; Buschke, Franz; Galante, Maurice (Univ. of California, San Francisco). Radiology; 96: 137-43 (Jul 1970).

The treatment experience in 173 cases of carcinoma of the oral cavity was analyzed. Radical irradiation followed by surgery, or a planned combination of preoperative irradiation and radical surgery constituted the treatment plan. Lesions of the anterior pillar appear to benefit from the planned combination of irradiation and surgery, while other lesions of the oral cavity, especially floor of mouth, can be effectively managed by primary radical irradiation with adjunctive surgery for failure. No increase in morbidity was noted in the combined cases even when surgery was utilized for failure at a comparatively long interval after irradiation. (auth)

39544 INTRAOCULAR HEAVY PARTICLE RADIATION OF EXPERIMENTAL MALIGNANT MELANOMA IN RABBITS. Krohn, David L. (Inst. for Medical Research and Studies, New York. Brookhaven National Lab., Upton, N. Y.); Brandt, Richard; Straub, Rita F.; Robertson, James S. Amer. J. Ophthalmol.; 69: 1047-52(Jun 1970).

A preliminary experiment to evaluate the therapeutic possibilities of the ^{10}B-thermal neutron effect for irradiation of the interior of the eye was conducted in rabbits using the Greene amelanotic malignant melanoma as a biological indicator. Full tumor inhibition was achieved in 14 of 25 eyes, of which six survived functionally and anatomically intact, and eight suffered destructive irradiation effect. Of the remaining 11 eyes, all showed some tumor growth inhibition, relative to the fellow eye which served as a control. (auth)

Radiation Effects on Animals

Refer also to abstracts 39144, 39412, 39428, and 39450.

39545 DIMERIZATION OF PYRIMIDINE BASES OF DNA OF HeLa CELLS DURING ULTRAVIOLET IRRADIATION AND CUTTING OUT OF DIMERS DURING DARK REPAIR. Soifer, V. N.; Matusevich, L. L.; Goroshkina, G. I. (Inst. of General Genetics, Moscow). Radiobiologiya; 10: 275-8(Mar-Apr 1970).

HeLa cells, labeled with ^{3}H-thymidine, were irradiated in the cold with uv light. The thymine dimers formed were determined by paper chromatography, finding the ratio of the radioactivity of the thymine dimer to the radioactivity of the thymine region. The kinetics of the formation of the thymine dimers as a function of

the irradiation dose was studied. The amount of thymine dimers in irradiated HeLa cells increased as a linear function of the irradiation dose, reaching a plateau after a 15-minute dose of irradiation. In the incubation of cells after irradiation, there was a cutting out of the dimers, and the amount of the dimers decreased by approximately 40% in the acid-insoluble fraction in comparison with unincubated irradiated cells. (auth)

39546 DOSE-RATE EFFECTS FOR VARIOUS DOSE RATES OF ^{252}Cf RADIATION ON HeLa CELLS IN CULTURE. Fairchild, R. G.; Drew, R. M.; Atkins, H. L. (Brookhaven National Lab., Upton, N. Y.). Radiology; 96: 171-4(Jul 1970).

Californium-252, a spontaneously fissioning neutron source, has been incorporated into needles and afterloading cells for use in radiation therapy of tumors. Pretherapeutic experiments are necessary in order to investigate effects of cellular recovery during protracted irradiation. This paper reports effects of various dose rates of ^{252}Cf on human cancer (HeLa) cells in culture by measuring survival-curve parameters. When an attempt was made to correct for changing cellular multiplicities during irradiation, exponential survival curves that were similar to those obtained with acute irradiation with fission neutrons were constructed. At the dose rate of 16.0 rads per hour, cell division was inhibited. (auth)

Invertebrates

Refer also to abstracts 39437 and 39519.

Vertebrates

Refer also to abstracts 39370, 39418, 39419, 39438, 39441, 39443, 39477, 39478, 39516, 39518, 39523, and 39591.

39547 (CONF-700310-2) VISUAL DETECTION OF X RAYS IN THE RHESUS MONKEY. Chaddock, Thomas; Smith, James C. (Florida State Univ., Tallahassee. Psychobiology Research Center). [1970]. 13p.

From 18th Annual Meeting of the Radiation Research Society, Dallas, Tex.

The results of trials involving monkeys indicate that there is a visual component to the immediate detection of x rays. In olfactory studies, visual detection may be ruled out because of data which indicates that detection is impossible in well light-adapted animals. (auth)

39548 (COO-1602-18) MODIFICATION OF RAT TESTICULAR RESPONSE TO X-IRRADIATION BY VARIOUS LIGHTING REGIMES. I. THE PINEAL GLAND AND MELATONIN SYNTHESIS AS A POSSIBLE MEDIATOR OF THE RESPONSE. Ellis, LeGrande C.; Van Kampen, Kent R. (Utah State Univ., Logan. Dept. of Zoology. Utah Univ., Salt Lake City. Coll. of Medicine). 21 Apr 1970. Contract AT(11-1)-1602. 11p. (CONF-700410-1). Dep. CFSTI.

54th Annual Meeting of the Federation of American Societies for Experimental Biology, Atlantic City, N. J.

Melatonin synthesis (HIOMT activity) was followed in 12-week-old male rats for 31 days after exposure to 350 R of whole-body x irradiation. Melatonin synthesis was diminished in rate during the first 24 hrs, but from day four through day 19 melatonin synthesis was increased. From day 22 to day 31 melatonin synthesis did not differ from the sham-irradiated animals. Exposure of irradiated rats to 350 R of x irradiation diminished testicular weight. Placing irradiated rats in constant darkness for 25 days after treatment increased the weight loss that was additive to the irradiation effect. Melatonin synthesis was decreased in these animals when compared to either the control or irradiated rats placed in normal lighting. Placing rats in constant darkness or constant light for six days prior to and 19 days after irradiation with 450 R both resulted in a radioprotective effect on the testis. Only the constant-light treated rats showed a change in melatonin synthesis at the time of necropsy, and it was decreased below either the control or irradiated groups. (auth)

39549 (EUR-4405) PATHOGENESIS OF GENETIC AND SOMATIC RADIATION DAMAGE. Final Report, 1965-1967. Annual Report, 1967. (Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Biologie). 1970. 22p. (In German). Dep. CFSTI (U. S. Sales Only). DM 3,20.

The research program is pursuing experimental studies on the frequency and origin of somatic and genetic radiation damage from irradiation administered externally or after incorporation of radioactive nuclides. The research covers selected problems in the following three fields: Radiation genetics of vertebrates, Neurophysiological studies and behavioural studies, Radiotoxicity. (auth)

39550 (JPRS-50894) BIOLOGICAL EFFECTS OF LASER RADIATION. Translation of Russian papers. 15p. CFSTI.

Separate abstracts were prepared for each of the two papers presented. (C.O.)

For abstracts of individual papers see: 39551 and 39552.

39551 (JPRS-50894, pp 1-11) LENTICULAR CHANGES INDUCED BY LASER RADIATION. Simakov, Yu. G.; Poluektova, L. M.; Popov, V. V. Translated from Zh. Obshch. Biol.; 31: 353-60(May-Jun 1970).

Laser beams, at a wave length of 10,600 Å, focused on the nucleus of the eye lens of Rana temporaria, induced primary lesions immediately after irradiation, which consist of formation of cracks and vacuoles on the posterior pole of the lens. Thereafter, about half the exposed lenses become opaque within a week. The other half of the lenses, in spite of the primary lesion, remained transparent and annular cataract did not develop. If the laser beam hits the iris, energy is absorbed by the pigment of the iris and the heat emitted damages the laminar zone and anterior pole of the lens, causing coagulation of protein molecules right after irradiation. Opacity of the lens was observed following exposure to doses of 0.18, 0.12, as well as 0.04 J; the only difference was that at the higher doses the cataract developed sooner and the lenticular lesions were larger. The question of whether focused laser beams will have a similar effect on the lens of warm-blooded animals can be answered only after experiments are done on mammals and birds that would help determine whether or not laser beams used to repair laminated human retinas are dangerous for the crystalline lens. (auth)

39552 (JPRS-50894, pp 12-15) CHANGE IN LEAD CONTENT OF EYE LENSES EXPOSED TO LASER RADIATION. Simakov, Yu. G.; Poluektova, L. M.; Popov, V. V. Translated from Biofizika; 15: 554-6(May-Jun 1970).

The effect of laser beams focused on the lenticular nucleus of Rana temporaria, at a wave length of 10,600 Å and energy of 0.18 and 0.12 J led to cataractous change, first in the equatorial zone, and in the entire lens after seven days. In the presence of laser cataract, there was a decrease in lead content in the zones involved. The zones not involved in the cataractous process contain the same quantity of lead as normal lenses. The lowest lead content was observed in the lens on the seventh post-irradiation day. In half the eyes exposed to doses of 0.18 and 0.12 J the lens did not become opaque, in spite of the fact that it sustained primary laser injury in the form of vacuoles and cracks on the posterior pole. The same occurred in lenses exposed to 0.04 J lasers. Lenses presenting only primary laser lesion contained a near-normal quantity of lead. (auth)

39553 (ORAU-109) THEORY OF QUANTITATIVE RADIATION-RESPONSE TIME-DATA. Bergner, Per-Erik E. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.). Oct 1969. 25p. Dep. CFSTI.

Preliminary results are given of an attempt to interpret partly unique clinical data obtained from patients with chronic lymphocytic leukemia. The data consist of white cell counts and platelet counts recorded for 42 days following a single, whole-body, therapeutic dose of γ radiation. A definition of the term — response mechanism — is given in terms of effect and repair functions, and the possibility of significant differences of practical value is shown by analyses. The influence of dose level on both the magnitude and the kinetics of the response mechanism is analyzed quantitatively, and the value of conceptual, as opposed to statistical, analysis of biomedical data is discussed. (E.R.B.)

39554 (ORNL-tr-2317) HYGIENE AND TECHNOLOGY OF FOOD PRODUCTS. Kossakowski, Stefan. Translated for Oak Ridge National Lab., Tenn., from Med. Wet. (Poland); 24: 449-53(1968). 11p. Dep. CFSTI.

The results of anatomical and pathological investigations of rabbits which had died of acute radiation sickness induced by exposure to doses of 1000 to 1200 R x radiation, indicated severe disorders in the vital activities of the organism, with the development of a number of characteristic morphological changes. Among these, changes in hematopoietic tissue, hemorrhagic phenomena, and particularly, ulceration of the digestive tract deserve special attention, as they provide definite possibilities for a diagnosis of acute radiation sickness in a slaughtered animal. Bacteriological blood examination of living animals cannot be considered as the indicator of the development of endogenous post-radiation bacteremia. The final indicator in this respect is an increase in body temperature to 40°C and higher. The results of a bacteriological examination of the internal organs and muscles of animals which died during the full development of radiation sickness indicate the possibility of the utilization of meat from slaughtered animals in the post-radiation period for consumption. This, of course, requires further detailed investigation. (auth)

39555 (RLO-2225-T-8-1) EFFECTS OF IRRADIATIONS, TEMPERATURE AND OTHER ENVIRONMENTAL FACTORS ON SALMONOID EMBRYOS. Progress Report. Welander, Arthur D (Washington Univ., Seattle. Lab. of Radiation Ecology). 15 Jun 1970. Contract AT(45-1)-2225. 37p. Dep. CFSTI.

The purpose of the research is to study the effects of ionizing radiation on the embryological stages of salmonids reared at different temperatures. Irradiation dose, which ranged from 12 R to 1500 R (approximately 100 r/min.), in geometric progression, was delivered to seven different embryological stages. The fish were irradiated and reared at temperatures ranging from 8.5°C to 17.2°C, and the effects on survival, growth, morphology and fecundity noted. These experiments indicate accelerated growth, not only by higher temperatures, but also by certain doses of ionizing radiation administered at critical developmental stages. Doses greater than 300 R appear to lower the tolerance to high temperatures and temperatures above 15°C prove lethal for young chinook salmon independent of irradiation. Rainbow trout survive in water over 18°C. More than 24,000 chinook salmon eggs have been used in this study, many of which were reared well beyond the feeding stages. In the spring of 1968, 469 rainbow trout eggs, irradiated with 21, 83, and 207 R at eyed stage were raised at comparatively high temperatures. These fish were spawned during the spring of 1970 with 65 females producing 176,000 eggs; 101,000 eggs have survived to the eyed stage. A limited number of these eggs, representing 9 experimental groups, will be held through the feeding stage for further observation. (auth)

39556 (UCD-34-P-187-1) HEMATOPOIETIC REPOPULATION FOLLOWING IRRADIATION INJURY. Progress Report, September 1, 1969-May 31, 1970. Lewis, Jerry P.; O'Grady, Lois F. (California Univ., Davis. School of Medicine). Contract AT(04-3)-34. 37p. Dep. CFSTI.

Effects of x radiation on hematopoietic repopulation in mice were studied. In Regimen A studies an $LD_{100/30}$ dose of radiation followed by a 50% protective dose ($PD_{50/30}$) of syngeneic marrow was used; in Regimen B studies an $LD_{50/30}$ dose of radiation followed by the same protective dose was used; in Regimen C studies an $LD_{100/30}$ dose of radiation with lead shielding of both legs was used. It was found that the modal day of death in Regimen A was 11 days and for Regimen B was 17 days. Splenic hematopoiesis was extensive in Regimen A studies and nonexistent in Regimen B animals. Stem cell renewal in Regimen A occurred between the fifth and sixth day post-mortem. In Regimen B stem cell renewal in the spleen was not present through day 7. Erythrocyte iron-59 incorporation was greater 8 and 12 days post radiation in Regimen A mice than in Regimen B mice. Splenic weight increased at an earlier time under conditions of Regimen A than under conditions of Regimen B. (H.L.W.)

39557 THE ROLE OF BIOLOGICALLY ACTIVE SUBSTANCES (RADIOTOXINS) IN RADIATION SICKNESS. Kudryashov, Yu. B.; Goncharenko, E. N. (Moscow State Univ.). Radiobiologiya; 10: 212-29(Mar-Apr 1970).

The problem of the formation and biological role of radiotoxins is reviewed and discussed. The main attention is paid to the primary radiotoxins, lipid radiotoxins and quinone-like substances (quinones) and secondary radiotoxins, products of protein decomposition, histamines, and choline. A scheme of formation of a complex of radiotoxins producing the radiation toxic effect is presented. The place and role of individual radiotoxins in the complex manifestation of the radiation toxic effect, one of the most important factors in radiation sickness, is discussed. Material is cited on the mediator role of the oxidation products of unsaturated fatty acids during the irradiation of biosubstrates. The question of the participation of primary radiotoxins in the origin and development of primary oxidative radiation reactions is considered. (auth)

39558 RADIATION BIOCHEMISTRY. VOLUME I. CELLS. Altman, Kurt I.; Gerber, Georg B.; Okada, Shigefumi. New York; Academic Press Inc. (1970). 378p. $17.00.

The biochemical changes in tissues and fluids of mammals induced by exposure to ionizing radiation are discussed in relation to molecular and cellular changes. Emphasis is placed on the biochemistry of metabolic changes induced by radiation exposure. (C.H.)

39559 MULTIPLE TUMORS IN A MACACA MULATTA MONKEY. Allen, James R.; Houser, Wallace D.; Carstens, Laurine A. (Univ. of Wisconsin, Madison). Arch. Pathol.; 90: 167-75(Aug 1970).

An 18-year-old female Macaca mulatta monkey that had received 1,100 R of x irradiation between the ages of two and six years, and was subsequently used in various psychological experiments, developed severe diarrhea and died. The findings at necropsy included multiple bronchial adenomas of the lung, a transitional cell carcinoma of the urinary bladder, cystadenocarcinoma and granulosa cell tumor of the right ovary, cystadenoma of the left ovary, and leiomyoma of the uterus. In addition to the multiple neoplasms, the animal had severe intestinal amebiasis, peliosis hepatitis, multiple cysts of the kidney, pyelonephritis, and glomerulosclerosis. (auth)

39560 EFFECT OF COLCHICINE TIME AND CONCENTRATION ON MITOSIS OF BONE MARROW CELLS FROM IRRADIATED AND UNIRRADIATED MICE IN VIVO. Prasad, N.; Bushong, S. C. (Baylor Coll. of Medicine., Houston, Tex. Veterans Administration Hospital, Houston, Tex.). Exp. Cell Res.; 60: 448-51(Jun 1970).

Mitotic activity in the bone marrow cells of irradiated and unirradiated mice was determined for various periods of exposure to colchicine (from 45 min to 3 hr) and for concentrations of 1.2 and 4 μg/g body weight (b.w.). The mitotic activity was calculated from the relative number of metaphase cells in a chromosome preparation. Although maximum mitotic activity was observed following colchicine for 3 hr at 4 μg/g, 3 hr exposure at 2 μg/g resulted in sufficiently large numbers of well spread chromosomes for cytogenetic analysis. It was observed that in the irradiated mice, there were fewer bone marrow cells; however, these cells had a higher mitotic activity than the cells from the un-irradiated mice. (auth)

39561 PROCEEDINGS OF THE IOWA ACADEMY OF SCIENCE FOR 1969. VOLUME 76. The Seventy-Ninth Session, Held at Des Moines, April 18-19, 1969. Meglitsch, Paul A. (ed.). Des Moines, Iowa; State of Iowa (1970). 525p. (CONF-690443).

Separate abstracts were prepared on two papers. Other papers present the results of recent studies in the fields of botany, chemistry, conservation, geology, physiology, zoology, and science teaching. (C.H.)

For abstracts of individual papers see: 39482 and 39562.

39562 EFFECT OF AN ELECTROMAGNETIC FIELD ON EARLY EMBRYOGENESIS IN QUAIL. Knutson, Thomas (Drake Univ., Des Moines, Iowa). Proc. Iowa Acad. Sci.; 76: 510-16 (1970).

From 79th Proceedings of the Academy of Science, Des Moines, Iowa. See CONF-690443.

Incubating quail embryos in a magnetic field resulted in accelerated somite growth. Twenty percent of the experimental embryos in one series of experiments exhibited reversed torsion. The heterogenous magnetic field as opposed to the homogenous magnetic field was more effective in causing these effects. The theory of magnetic action on a biological system is discussed. (auth)

39563 EFFECTS OF X-IRRADIATION ON LACTATE DEHYDROGENASE ISOZYMES IN PLASMA AND IN VARIOUS ORGANS OF MICE. Hori, Yasuharu; Takamori, Yasuhiko; Nishio, Kazuo (Radiation Center, Sakai, Japan). Radiat. Res.; 43: 143-51 (Jul 1970).

Male mice of the RF strain, six to eight weeks old, were given a single exposure to whole-body x irradiation. Lactate dehydrogenase isozymes in plasma and in various organs were separated by means of disc-gel electrophoresis. An increase of M-LDH fractions was observed in the plasma of mice a few hours after irradiation with sublethal or lethal dose. This was also proved by the experiments of substrate inhibition by pyruvate. This alteration in the composition of plasma LDH isozymes occurred coincidentally with the changes in total plasma LDH activity. LDH isozyme patterns in organs showed no remarkable change at six hours after exposure to 1000 R, though radiosensitive thymus and spleen exhibited a marked loss of LDH activity after exposure. In the split-dose study, no noticeable change in plasma LDH isozyme patterns was found after the second exposure. From these results it is assumed that the radiosensitive cells containing the preponderance of M-LDH fractions may be possible sources of the increased amounts of plasma LDH after exposure. (auth)

39564 PROBABLE ROLE FOR PROTEIN SYNTHESIS IN INTESTINAL EPITHELIAL CELL DAMAGE INDUCED IN VIVO BY CYTOSINE ARABINOSIDE, NITROGEN MUSTARD, OR X-IRRADIATION. Lieberman, Michael W.; Verbin, Robert S.; Landay, Michael; Liang, Hilda; Farber, Emmanuel; Lee, Tsun-nin; Starr, Russell (Univ. of Pittsburgh. New York Univ., N. Y.). Cancer Res.; 30: 942-51(Apr 1970).

Cell death induced in vivo in the continuously dividing intestinal crypt epithelial cells in rats by 1-β-D-arabinofuranosylcytosine, nitrogen mustard, or x irradiation was prevented by two agents which inhibit protein synthesis: cycloheximide and tenuazonic

acid. Both pretreatment and posttreatment (up to 45 min), in doses sufficient to produce an 80% drop in the rate of protein synthesis, were effective. Protection against hydroxyurea-induced cell death is similar but more variable. Our data suggest that, in this system, the active metabolic response of the cell (protein synthesis), to injurious agents, rather than mere passive attrition, is necessary for cell death. While protective to the intestinal crypt epithelium, inhibitors of protein synthesis enhance damage to lymphoid cells. It is suggested that these agents may be useful adjuncts to the x ray and chemical treatment of lymphomas. (auth)

39565 PERSISTENT IMPAIRMENT OF HAIR GROWTH AFTER SINGLE LARGE DOSES OF X-RAYS. Malkinson, Frederick D.; Griem, Malvin L.; Marianovic, Ruzica (Presbyterian-St. Luke's Hospital, Chicago. Univ. of Illinois, Urbana. Argonne Cancer Research Hospital, Chicago. Univ. of Chicago). Radiat. Res.; 43: 83-91(Jul 1970).

Telogen mouse hairs treated with single doses of 2000 to 2500 Rads showed persistent impairment of postirradiation growth as measured by determinations of overall hair length. Reductions in length of surviving hairs, compared to contralateral controls, averaged 27% for the hairs newly grown postirradiation. Subsequent hair generations showed no significant recovery: reductions in length of hairs from the same treatment sites averaged 33% 10 months after irradiation. Cyclic regrowth of hair in these areas was also unusually slow; after plucking, hair density was not fully restored in irradiated areas for four weeks or longer in contrast to the normal replacement time of two weeks observed in plucked control sites. This change was demonstrable up to 14 months postirradiation. Exposure of telogen hairs to a somewhat smaller dose of 1500 Rads resulted in a 12% reduction of length in the generation of hairs growing immediately postirradiation, followed by complete recovery in the subsequent cycle of hair growth. The persistence of effects in the animals subjected to high doses of radiation may be the result of overall reduction in stem cell pool size since investigations with tritiated thymidine showed that cell generation cycles were almost identical in treatment and control sites but that the mitotic index was substantially reduced in the irradiated areas. (auth)

39566 IMMEDIATE RESPIRATORY CHANGES RESULTING FROM OLFACTORY STIMULATION BY X-RAYS. Cooper, G. P. (Univ. of Cincinnati). Contract AT(11-1)-1669. Radiat. Res.; 43: 105-11(Jul 1970). (COO-1669-8).

An increase in respiratory rate occurred in lightly anesthetized or unanesthetized rats within 0.5 seconds after the beginning of x irradiation of the whole animal (250 kVp; 3 R/second). Irradiation of the body only was ineffective. Experiments with rats having lesions of the olfactory bulbs or lesions of the cerebral cortex revealed that the respiratory changes were largely, if not entirely, due to olfactory stimulation by x rays. Thus, the arousal effect of olfactory stimulation by ionizing radiation is sufficiently strong to evoke immediate and striking alterations in respiratory rate even in anesthetized animals. (auth)

39567 CHANGES IN THE RAT INTESTINE AFTER X-IRRADIATION OF EXTERIORIZED SHORT SEGMENTS OF ILEUM. Osborne, J. W.; Prasad, K. N.; Zimmerman, G. R. (Univ. of Iowa, Iowa City). Radiat. Res.; 43: 131-42(Jul 1970).

Segments of rat ileum 2.5 or 7.5 cm in length were x irradiated with 3000 or 5000 R under conditions of normal or restricted blood flow to the intestine. Most animals were allowed to live their life span for mortality studies, but others were killed between Day 5 and Day 44 for an assessment of the progression of histological changes in the irradiated segment. Time of death after irradiation was variable in each treatment category. Most animals died between 10 and 100 days; some lived beyond 200 days. The blood flow-restriction procedure extended the life span in the 3000 R 7.5-cm group, but was ineffective at 5000 R regardless of segment length. A lesion characterized by serosal fibrosis apparently secondary to mucosal ulceration was always produced, but the latent period between the events and the extent of fibrosis varied considerably. Death was almost always caused by bowel obstruction. In the 2.5-cm segment exposed to 5000 R, the mucosa did not regenerate in 44 days, but in some of the 7.5-cm segments subjected to 3000 R, it did. The regeneration of mucosa was not an effective deterrent to the development of fibrosis as none of the animals lived a normal life span and when autopsied, an intestinal lesion was found. (auth)

39568 EFFECT OF VINBLASTINE ON COMPENSATORY RENAL GROWTH. Cosgriff, Thomas M.; Sudarsanam, Anam (Univ. of Minnesota, Minneapolis). Growth; 34: 187-96(Jun 1970).

Male CAF_1/J mice, nine weeks of age, were injected with vinblastine sulfate intraperitoneally four hours prior to uninephrectomy. In addition, some animals were treated with partial-body x irradiation to the area of the remaining kidney. Kidney weight was determined for the left kidney (L) at the time of nephrectomy, and for the right kidney (R) 20 days post-nephrectomy, when the mice were sacrificed. The ratio of right kidney weight to left kidney weight (R/L) served as the parameter for comparing treatment effects on compensatory renal growth. Mice treated with vinblastine have larger mean R/L ratios than controls for all doses of vinblastine employed. In irradiated animals, treatment with vinblastine results in a similar increase in the mean R/L ratio. The pooled difference for all experiments is significant at P less than 0.001. This difference is determined by comparing the mean R/L ratio of all animals treated with vinblastine with that for animals that did not receive the drug. This action of vinblastine possibly relates to known effects of the drug on energy metabolism or on nucleic acid synthesis. (auth)

39569 GASTROINTESTINAL MICROFLORA OF IRRADIATED MICE. II. EFFECT OF ORAL ANTIBIOTIC ADMINISTRATION ON THE COLONIC FLORA AND SURVIVAL OF ADULT MICE. Livstone, Elliot M.; Hersh, Theodore; Spiro, Howard M.; Floch, Martin H. (Yale Univ., New Haven). Yale J. Biol. Med.; 42: 448-54(Jun 1970).

Adult white ICR mice were x irradiated with 1200 R and given oral neomycin and penicillin. Control groups were also studied. Segments of colon were obtained 1, 3, 5, 7, and 10 days after the day of irradiation and were studied by light microscopy; at the same times, specimens of colonic feces were obtained for quantitative and qualitative aerobic and anaerobic bacterial cultures. Survivors and nonsurvivors from each group were counted for 30 days. Irradiated adult mice demonstrated a significant increase of total aerobic, total anaerobic, and coliform bacteria. The antibiotic regimen eliminated all recoverable bacteria from the fecal samples and permitted the subsequent proliferation of aerobic and anaerobic fungi. The suppression of bacteria in the colonic feces was not associated with prolongation of life nor reduction of mortality in these irradiated mice. It was concluded that tissue damage is more important than bacterial proliferation for the ultimate survival of the host animal. (auth)

39570 GASTROINTESTINAL MICROFLORA OF IRRADIATED MICE. I. RELATIONSHIP OF MUCOSA AND MICROFLORA IN WEANLING MICE. Livstone, Elliot M.; Spiro, Howard M.; Hersh, Theodore; Floch, Martin H. (Yale Univ., New Haven). Yale J. Biol. Med.; 42: 439-47(Jun 1970).

Mice were given 1200 R of total-body x radiation. The bacteriology of the lumen and wall of the stomach, small intestine, and colon were studied for ten days after irradiation. Results were subjected to stringent statistical analysis and were correlated with histologic observations. Coliforms and total aerobes, but not anaerobes, significantly increased, but not massively, above control levels in the lumenal contents of the colon, in washings of the colonic wall, and in homogenates of colon. No significant increases were noted in the stomach or small bowel flora. All increases in bacterial counts occurred as agonal or pre-agonal events. On microscopic examination, bacteria were seen in the lumen of all organs studied. Maximal mucosal injury occurs at the first to third day after 1200 R radiation. No microabscesses or progressive cellulitis could be seen in damaged gastrointestinal tissue, but this is attributed to the animal's inability to form such abscesses secondary to bone marrow and lymphoid tissue suppression. It is concluded that bacteria proliferate in the colonic lumen following irradiation, and subsequently may invade the intestinal wall producing bacteremia and contributing to death; however, massive bacterial proliferation does not occur. (auth)

39571 ANAMNESTIC RESPONSE TO LEPTOSPIRA CANICOLA AND INFECTIOUS CANINE HEPATITIS ANTIGENS IN BEAGLES EXPOSED TO ^{90}Sr BY INHALATION OR INTRAVENOUS INJECTION. Clapper, W. E.; Boecker, B. B.; Sanchez, A.; Levy, J. Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Radiat. Res.; 43: 112-30(Jul 1970).

The anamnestic response to Leptospira canicola and infectious canine hepatitis (ICH) virus was studied in beagles exposed to ^{90}Sr by aerosol inhalation and intravenous injection. In addition to untreated controls, two groups of dogs, exposed by inhalation one to three days before being given the test secondary immunizing stimuli, received mean initial body burdens of 35 and 220 $\mu Ci/kg$ β irradiation, respectively, and a third group given intravenous injections received an average initial body burden of 69 $\mu Ci/kg$. The responses in both control and exposed animals reached peak titer for each antigen in 10 days, but titers in all exposed groups were partially depressed. The percentage of depression of titer as compared to controls was directly related to the initial body burden and to the cumulative absorbed β doses to the skeleton.

Dogs with the lower body burdens recovered their ability to produce antibodies after five months. Data from this and earlier investigations indicate that an initial body burden of 35 μCi/kg from inhalation of ^{90}Sr produced an effect equivalent to that from external x irradiation of dogs near LD_{50} (30) doses (300 to 400 R). The results suggest that a protective effect might be achieved in humans given a booster vaccination after an accidental internal exposure to ^{90}Sr. The expected response could be obtained by measuring the initial whole-body burden or the 12-day cumulative dose. (auth)

39572 COMPARATIVE TOXICITY OF ^{224}Ra, ^{239}Pu, ^{224}Th, ^{228}Ra, AND ^{90}Sr TO LEUKOCYTES OF BEAGLES. Dougherty, Jean H.; Rosenblatt, Leon S. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. Radiat. Res.: 43: 56-70(Jul 1970).

The effectiveness of five internal emitters in depressing blood leukocytes in young adult beagles was studied during the first year postinjection. The radionuclides, ^{226}Ra, ^{239}Pu, ^{228}Th, ^{228}Ra, and ^{90}Sr, were given as a single intravenous injection, at six to seven injection levels per radionuclide. The occurrence of dose-dependent depressions in leukocytes had been previously established. The greatest depression was found in polymorphonuclear leukocytes (pmns), monocytes, and eosinophils while lymphocytes were depressed to a lesser extent. The probit transform was used to linearly relate response to the logarithm of the injected activity. Injected activities required to produce a 50% leukocyte depression (ED_{50}) were computed for eight time periods. Toxicity indices were also computed for four radionuclides relative to ^{226}Ra as a standard and converted to hematological RBE, again relative to ^{226}Ra. For pmns and lymphocytes median values of RBE estimated over the eight time periods were: $^{228}Th \sim 4$; $^{239}Pu \sim 4$; $^{228}Ra \sim 1.5$, and $^{90}Sr \sim 0.5$. Alpha emitters depositing on bone surfaces were more effective in reducing leukocytes than those which are volume seekers. The beta emitter, ^{90}Sr, was less effective than the alpha emitters rad for rad. (auth)

39573 EFFECTS OF FEEDING ^{90}Y-LABELED FALLOUT SIMULANT TO SHEEP. Bell, M. C.; Sasser, L. B.; West, J. L.; Wade, L. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-gen-242. Radiat. Res.; 43: 71-82(Jul 1970).

A fallout simulant (88 to 176 μ) with a specific activity of 5 to 12 mCi/g was mixed with moistened alfalfa pellets and fed to sheep for three consecutive days. Each of 35 wethers was fed a total of 1.9 to 7.5 mCi/kg over the three day period. Most of the sheep developed signs of digestive disturbances including anorexia, diarrhea, and pyrexia. Sixteen treated and six control sheep were sacrificed at different intervals after feeding. Major lesions were found in the abomasum and ventral and lateral areas of the rumen of treated animals. The mucosal surface of the rumen had small blister-like lesions in the early stages. Later, three or four areas of polyp-like or cauliflower-like masses measuring up to 12 cm were observed. The abomasum was usually edematous and inflamed with large focal areas of hemorrhagic necrosis of the mucosal surface. In severe cases, the serosal surface of both organs was adhered to adjacent tissues. Contrary to earlier predictions, no major damage was observed in the large intestine. In vitro uptake of ^{65}Zn by erythrocytes of the treated sheep was 8% compared with 3% for the control animals. (auth)

39574 COMPARISON OF IRRADIATION BY ^{252}Cf AND RADIUM ON THE SKIN OF SWINE. Atkins, H. L.; Fairchild, R. G.; Robertson, J. S. (Brookhaven National Lab., Upton, N. Y.). Radiology; 96: 161-5(Jul 1970).

Irradiation of pig skin was carried out with surface applicators containing radium (35 rads/hr) and ^{252}Cf (12 to 13 rads/hr.). Observations were made over a 100-day period and skin reactions scored. The dose required to produce a moist reaction that did not heal within fifty days was 8,400 rads for radium and 1,725 rads for californium; this yielded an RBE of 4.9. The results indicate very little recovery or repopulation during irradiation by californium-252. (auth)

39575 RADIOSENSITIVITY OF MAMMALIAN CELLS. IV. EFFECTS OF X-IRRADIATION ON THE DNA SYNTHETIC PERIOD IN SYNCHRONIZED CELLS. Walters, R. A.; Tobey, R. A. (Los Alamos Scientific Lab., N. Mex.). Biophys. J.; 10: 556-62 (Jun 1970).

The effect of x irradiation on the timing of DNA synthesis in cultured Chinese hamster ovary cells was investigated. Mitotically synchronized cells irradiated in mitosis or early G_1 exhibited a fixed, dose-independent (150 to 2000 rad) delay of 1.6 hr in entry into S, while the duration of S was unaffected. Cells irradiated during late G_1 or the first 0.8 hr of S were not affected either in time of initiation or duration of S. However, when cells 0.8 hr or more into S were irradiated, completion but not initiation of DNA synthesis was delayed, indicating a very precise separation of x ray effects upon initiation and replication. There was no indication of a reordering of cells following irradiation and recovery, since cells in G_2 at the time of irradiation always divided before cells irradiated in S. The results suggest that two separate functions required for initiation and continued replication of DNA may be differentially sensitive to x radiation. (auth)

39576 RADIOCYTOGENETIC DETERMINATION OF THE OXYGEN ENHANCEMENT RATIO OF ^{252}Cf. Bushong, Stewart C.; Prasad, Naresh; Briney, Sharon A.; Oliver, George D. (Baylor Univ., Houston, Tex. Univ. of Texas, Houston). Radiology; 96: 167-70(Jul 1970).

Californium-252 was studied as a possible replacement for ^{226}Ra in radiation therapy. Irradiation of Chinese hamster cells with ^{252}Cf produced an aerobic and anaerobic aberration frequency of 0.0135 and 0.0077 single-hit chromosome aberrations per cell per rad, respectively. The oxygen enhancement ratio was 1.75. This study suggests that ^{252}Cf may be more effective than ^{226}Ra in the treatment of malignant disease. (auth)

39577 EFFECT OF IONIZING RADIATIONS ON DISTRIBUTION OF PLASMA PROTEIN-BOUND NEUTRAL HEXOSES IN MICE AND DOGS. Evans, Adelbert S. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Radiat. Res.; 43: 152-60(Jul 1970).

Comparison of changes in concentration of protein-bound carbohydrates (PBC) as neutral hexoses in the plasma of C_3H mice and beagles as a function of time after exposure to mixed γ-neutron radiations revealed that the two species react similarly. The animals which died exhibited a marked increase in plasma PBC concentration while the survivors deviated only slightly from their preirradiation values. Analytical acrylamide gel electrophoresis demonstrated that distinctive, progressive postirradiation changes occurred in the plasma of the animals which succumbed. The most striking changes were in the components tentatively identified as transferrin, haptoglobins, and α_2-macroglobulin. Preparative fractionation of plasma of both mice and dogs by combined molecular sieving and ion-exchange chromatography revealed that, in the four fractions uniformly obtained, absolute changes in PBC regularly occurred only in the first and third. The protein composition of these fractions and their significance as a prognostic tool in radiation injury are discussed. The suggestion that the preirradiation PBC concentration may constitute a crude index to radiosensitivity was confirmed under conditions specifically designed to test the thesis. (auth)

39578 INFLUENCE OF ALTITUDE ON LATE EFFECTS OF RADIATION IN RF/Un MICE: OBSERVATIONS ON SURVIVAL TIME, BLOOD CHANGES, BODY WEIGHT, AND INCIDENCE OF NEOPLASMS. Mori-Chavez, Pablo; Upton, Arthur C.; Salazar J., Maximo; Conklin, J. W. (Univ. Peruna Cayetano Heredia, Lima. Oak Ridge National Lab., Tenn.). Cancer Res.; 30: 913-28(Apr 1970).

RF female mice were sham-irradiated (as controls) or given 150 or 300 R x rays to the whole body at 10 weeks of age and kept for the duration of their lives either at sea level or high altitude (14,900 feet). On ascent to high altitude, the mice showed a rapid, marked erythropoietic response, which was not detectably impaired by earlier irradiation. With advancing age, the erythrocyte count and hemoglobin level gradually increased in the mice at high altitude, whereas the reverse occurred in the mice kept at sea level. As the mice aged the granulocyte count also increased, but the mononuclear cell count decreased; neither change was detectably affected by irradiation or altitude. The life-span of the mice decreased with increasing radiation dose and was shorter in all groups (including controls) at high altitude than at sea level. Body weight gain was impaired in mice at high altitude, and the overall incidence of neoplasms was lower than in the mice at sea level. (C.H.)

39579 ACTION OF SOME DIVALENT CATIONS ON THE CONTRACTILE AND ELECTRIC ACTIVITY OF ISOLATED RAT DIAPHRAGM. Przybyslawski, J.; Reiss, Genevieve; Danet, Rose-Marie (Faculte des Sciences, Orsay, France). J. Physiol. (Paris), Suppl.; 60: No. 2, 524(1968). (In French).

The effect of Cd^{2+} and UO_2^{2+} on the contractile and electric activity of isolated rat diaphragm was investigated. At concentrations of 0.2 to 0.3 mm/l, Cd^{2+} caused an increase in the amplitude and the total duration of jerks; the duration of the ascending phase was only slightly modified. The duration of the descending phase was elongated and this elongation was still accentuated after return to a normal medium. The action potential had a prolonged total duration and the prolongation was increased with the length of time in the Cd^{2+} medium. At UO_2^{2+} concentrations about 1 μm/l, there was an increase in the amplitude of the jerks, but a sharp decrease in the total duration, the duration of the ascending phase, and the

duration of the descending phase. The action potential was not modified. (J.S.R.)

39580 CARCINOGEN-INDUCED MAMMARY TUMORS FROM PRENEOPLASTIC NODULE OUTGROWTHS IN BALB/c MICE. Medina, D.; DeOme, K. B. (Univ. of California, Berkeley). Cancer Res.; 30: 1055-9(Apr 1970).

The oncogenic effect of two chemical carcinogens, 7,12-dimethylbenz(a)anthracene and urethan, and of γ irradiation was tested on two of the D series of BALB/c nodule outgrowth lines, D1 and D2 of mice. All three agents increased the tumor-producing capabilities of nodule outgrowth line D1, and γ irradiation also increased the tumor-producing capabilities of nodule outgrowth line D2. The two chemical carcinogens were not tested on D2. The tumor-producing capabilities of the nodule outgrowth lines were dependent both on the particular carcinogen tested and on the nodule outgrowth line used. Nodule outgrowth line D1 treated with urethan or with 7,12-dimethylbenz(a)anthracene produced 76% and 64% tumors, respectively, whereas irradiated outgrowth line D1 produced only 22% tumors. Untreated D1 outgrowth produced only 4% tumors. On the other hand, irradiated outgrowth line D2 produced 61% tumors, whereas untreated D2 outgrowths produced 14% tumors. Blood from carcinogen-treated mice and cell-free extracts of tumors arising in carcinogen-treated outgrowths were assayed for the presence of mammary tumor virus activity by the noduligenic assay. In addition, thin sections of carcinogen-treated outgrowths and tumors derived from carcinogen-treated outgrowths were examined under the electron microscope for the presence of A and B particles. Neither virus particles nor evidence of mammary tumor virus activity were encountered. (auth)

Man

Refer also to abstracts 39435, 39472, 39501, 39503, 39540, and 39541.

39581 (CEA-CONF-1450) EVOLUTION OF TWO CHRONIC LYMPHOID LEUKEMIAS IN RELAPSE AFTER IRRADIATION OUTSIDE THE BODY. Hollard, D.; Kolodie, L.; Schaerer, R.; Suscillon, M. (Centre Hospitalier et Universitaire de Grenoble (France)). [nd]. 10p. (In French). (CONF-691032-1). Dep. CFSTI (U. S. Sales Only).

From Hematology Conference, Paris, France.

Preliminary results in the use of extracorporeal γ irradiation of blood for the treatment and study of chronic lymphoid leukemias are reported. The results showed the efficiency and the excellent tolerance of this treatment, either complementary to, or in place of, more classical treatments. Morphological and structural anomalies of the circulating cells were found. The principal anomalies found were variations of the mitotic index and chromosome aberrations. A delay in mitosis of leukemic cells, which disappeared when the number of leukocytes returned to normal, was observed. There was also a clear rise of cell indices during and after irradiation of the blood. The chromosome anomalies were considerable and preceded death of the cell. The absence of residual lesions in the resting cells or newly formed cells indicate a molecular destruction of the nucleic acids and a new synthesis of these acids by the cells of the subject after treatment. (tr-auth)

39582 (COO-1784-22) A STUDY OF THE PHYSIOLOGICAL FUNCTION AND HISTOLOGICAL CHANGES IN THYROIDS IRRADIATED WITH RADIOACTIVE IODINE. Progress Report, July 1, 1969-June 30, 1970. Dobyns, Brown M. (Case Western Reserve Univ., Cleveland, Ohio. School of Medicine). Contract AT(11-1)-1784. 11p. Dep. CFSTI.

Studies on effects of ^{131}I on the thyroid of hyperthyroid patients included pretreatment characterization of the thyroid gland and of the patients; determination of the amount of treatment dose taken up by the thyroid, followed by daily measurements over the gland thereafter to determine the disappearance curve of the isotope from the gland; multiple observations on the concentration of ^{131}I in the serum and excretion in the urine; quantitative determination of iodinated compounds in the serum; and total urinary excretion of ^{131}I. Neoplasms developing in thyroid tissue following treatment with ^{131}I were studied using rats; a variety of benign and malignant lesions were observed. Observations were made on the development of thyroid nodules in populations exposed to radioiodine fallout. Studies on the Marshallese exposed to the Bikini nuclear test in 1954 revealed the presence of thyroid nodules and bizarre nuclear forms in a significant number of individuals. Children in the Utah-Nevada area exposed to fallout in 1954 were examined for thyroid abnormalities. Experiments were conducted on rats to determine the possibility of spontaneous goiter arising in the offspring of mothers previously treated with ^{131}I. The relationship of bizarre nuclear forms to the persistence of the long acting thyroid stimulator in patients treated for Graves' disease was studied. Studies on chromosomes of circulating leukocytes in man following therapeutic doses of ^{131}I showed that the dose commonly used to treat Graves' disease caused aberrations such as dicentrics and ring forms. (H.L.W.)

39583 (PRNC-135, pp 239-44) GAMMA RADIATION EFFECTS ON THE MEMBRANE OF HUMAN RED BLOOD CELLS. Eberstadt, Peter L.; Coo Luna, Juan Jose (Universidad Nacional Autonoma de Mexico, Mexico City). (In Spanish).

From Radiation and isotope technology in Latin American development.

The effects produced by ionizing radiation on some of the functional properties of live cellular membranes were investigated. Human red blood cells (without nucleus) suspended in a saline solution were used. Quantitative measurements were made daily of the hemolysis in previously γ irradiated samples. Comparative readings were taken of non-irradiated blood samples. The samples studied received 10,000, 20,000, 30,000, and 40,000 rads. It appeared that the time necessary to produce hemolysis was reduced as dose was increased. Thus damage to cellular membranes has a direct relation to radiation dose. These studies can also lead to the proposal of new biological dosimetry system and help in the understanding of the physiological properties of cell membranes. (auth)

39584 LOW DOSE RADIATION AND CANCER. Gofman, John W.; Tamplin, Arthur R. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 1-9(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Contrary to a widespread notion that only leukemia plus certain rare cancers are radioinduced in man, the evidence now points strongly to the induction of all forms of human cancer plus leukemia by ionizing radiation. These data amply justify the following three general laws of radiation-induction of cancer in man: Law I; All forms of cancer, in all probability, can be increased by ionizing radiation, and the correct way to describe the phenomenon is either in terms of the dose required to double the spontaneous incidence rate of each cancer or, alternatively, as the increase in incidence rate of such cancers per rad of exposure. Law II; All forms of cancer show closely similar doubling doses and closely similar increases in incidence rate per rad. Law III; Youthful subjects require less radiation to increase the incidence rate by a specified fraction than do adults. The currently allowable radiation dose (Federal Radiation Council Guidelines) of 0.17 rads per year to the population-at-large from peaceful development of atomic energy would, if everyone received this dose, lead to a minimum estimate of 16,000 additional cancer plus leukemia cases annually in the USA. The only hope for a lower risk is either existence of a threshold or protection by protraction over time of the radiation damage. Since neither protraction nor threshold can be counted on, the only reasonable procedure is to revise the Federal Radiation Council guidelines downward by at least a factor of 10, to a dose of less than 0.017 rads per year for the allowable population exposure to ionizing radiation. (auth)

Radiation Effects on Plants

Refer also to abstracts 39144, 39370, 39427, 39431, 39462, 39475, 39476, 39480, 39482, 39484-39493, 39524, and 39537.

39585 (AERE-M-2302) NEW METHOD FOR DERIVING ENERGY REQUIREMENTS FOR RADIOBIOLOGICAL DAMAGE FROM CELL SURVIVAL CURVES. Holt, P. D. (Atomic Energy Research Establishment, Harwell (England)). Apr 1970. 7p. (CONF-690556-1). Dep. CFSTI (U. S. Sales Only). UK 1s. 9d.

From Joint Meeting of the Association for Radiation Research and the Netherlands Radiobiological Society, Petten, Netherlands.

At LET's below about 200 MeV $cm^2\ g^{-1}$ one-hit or irreparable damage is probably due to a δ-ray of some minimum energy rather than to a cluster of ionizations in the track core. It is likely also that the δ-ray must be in a particular configuration with respect to the molecular system in which it occurs. If some assumption is made about the necessary configuration, the minimum δ-ray energy may be deduced from the cell survival curve at low LET's. For example, if the δ-ray must lie within a cylinder of diameter 5 nm, then for diploid human cells, using Barendsen's data, a value of 0.36 keV is obtained, i.e. about 12 ions, in agreement with the value 5-15 ions estimated by Barendsen from the higher LET region where track core effects are predominant. This suggests that the value of 5 nm is reasonable, and using this value for

other cells it is deduced from published data the following very approximate requirements for damage: irreparable damage in haploid yeast 2 ions; repairable damage in haploid Chlamydomonas reinhardii 9 ions, and in diploid C. reinhardii 13 ions. (auth) (UK)

39586 (COO-78-228) CORRELATION BETWEEN SENSITIVITY TO IONIZING RADIATION AND DNA REPLICATION IN PHYSARUM POLYCEPHALUM. Nygaard, Oddvar F.; Brewer, Eugene N.; Evans, Thomas E.; Wolpaw, Jonathan R. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Radiology). [1970]. Contract W-31-109-eng-78. 8p. (CONF-700610-4). Dep. CFSTI.

From 4th International Congress of Radiation Research, Evian, France.

During the period of DNA replication the radiation sensitivity of the synchronously dividing plasmodial slime mold, Physarum polycephalum, in terms of delay of nuclear division, appears to be proportional to the amount of unreplicated DNA present at the time of irradiation. We have discussed this result in terms of repair of damage to the DNA, inhibition of DNA synthesis, and complementation among active, undamaged genes. (auth)

39587 (NP-18287) APPLICATION OF ATOMIC ENERGY IN AGRICULTURE. Annual Report, 1969. (Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen (Netherlands)). 1970. 85p. Dep. CFSTI (U. S. Sales Only).

The results of research during 1969 are reported under the following headings: applied aspects—a review of results ready or almost ready for practical application; scientific aspects—mutation breeding, mutation breeding—methodology, radiogenetics—ontogenetic factors, radiogenetics—physical and chemical factors, related genetic studies, related in vitro studies, preservation of food by means of radiation, induction of male sterility in insects by means of radiation, the behavior of specific nuclides in plant and soil, and related physical studies; radiation protection—a review of services rendered to third parties. (auth)

39588 (NP-tr-1897) POST-IRRADIATION RECOVERY OF YEAST CELLS FROM LETHAL AND SUBLETHAL DAMAGE SIMULTANEOUSLY. Barsukov, V. S.; Malinovskii, O. V.; Mityushova, N. M. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translated by A. Crozy (Atomic Energy Research Establishment, Harwell, Eng.), from Russian report, 17p. Dep. CFSTI (U. S. Sales Only).

The increased survival of resting yeasts following fractionated ^{60}Co γ irradiation and inoculation of the cells onto nutrient medium immediately after the second dose fraction may be explained only if it is assumed that the processes of recovery from lethal and sublethal damage proceed simultaneously. The process of recovery from lethal damage has a retarding influence on recovery from sublethal damage. This phenomenon is to be explained by the fact that on restoration the lethal damage is eliminated not as a single whole but gradually, passing at first into sublethal damage. It may be stated that the difference between the lethal and sublethal damage is quantitative before fixation of the lethal damage. If it is assumed that lethal damage represents nothing other than the result of interaction of sublethals then the facts outlined in the preceding conclusions find a satisfactory explanation. (auth)

39589 (PRNC-135, pp 109-12) ACTION OF BETA RADIATION UPON LEAVES OF VARIOUS LACTIFEROUS PLANTS (FAM MORACEAE). Patetta-Queirolo, M. A. (Carabobo Univ., Valencia (Venezuela). Facultad de Medicina). (In Spanish).

From Radiation and isotope technology in Latin American development.

The effect of β radiation from calibrated sources of ^{90}Sr, ^{85}Kr, ^{147}Pm and ^{90}Y on the leaves of different plants of the family Moraceae (Ficus elastica, Ficus carica, Artocarpus communis, Morus alba, Carica papaya, and Castilla elastica) was studied. In these lacticiferous plants, β radiation produced a brown pigmentation in the leaves in the irradiated field. Microscopic sections showed that the lacticifer vessels were full of this brown pigmentation, which can also be obtained by direct irradiation of the latex from these plants. (auth)

39590 INFLUENCE OF FRACTIONATED IRRADIATION OF THE SURVIVAL OF YEAST CELLS. Kabakova, N. M.; Kapul'tsevich, Yu. G.; Korogodin, V. I. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 10: 300-3(Mar-Apr 1970).

Cells of Saccharomyces cerevisiae, irradiated at a dose of 90 kR, were exposed for various periods in a recovery system, irradiated again, and the survival rate determined immediately after irradiation and after maximum recovery. At time intervals of one and two days between irradiations, the resistance of the cells to repeated irradiation was higher than to a single irradiation, while the survival of the cells that had undergone recovery after fractionated irradiation was higher than after a single irradiation at the summary dose. The effect of fractionation of irradiation disappeared in the case of a five-day time interval between irradiations. In all cases the survival curves of the cells after repeated irradiation were exponential. The data obtained cannot be explained by recovery of cells from sublethal damages. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 39428, 39434, 39436, 39450, and 39595.

39591 (PRNC-135, pp 215-23) MULTIPLICATION OF APHTHOUS (FOOT AND MOUTH DISEASE) IN PREVIOUSLY IRRADIATED TISSUE CULTURE AND ANIMALS. Mayo, J.; Rivenson, S.; Lombardo, J. H.; Abadie, G. J.; Smolko, E. E. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina). (In Spanish).

From Radiation and isotope technology in Latin American development.

The effect of γ radiation on the behavior of viral infection was investigated in tissue cultures, laboratory animals, and sheep. An increase of viral multiplication by cellular unit was obtained in kidney cultures from bovine fetus irradiated with doses of 500, 1000, 2000, and 4000 Rads and then inoculated with virus. When this was carried out with hamsters, mice, and adult rats which were naturally immune to the virus, it was shown that they became susceptible when exposed to whole-body irradiation doses of a lethal or more than lethal order. It was verified in hamsters that the passage of the virus through adult irradiated animals produces an increase of clinical manifestations of the viral infection; reduced survival of inoculated animals; increase in viral titer; and adaptation of the naturally non-susceptible normal adult animal to the types of aphthous virus used. When the tests were made in sheep, an increase was observed in viral titer which reached its highest value with the lethal doses compatible with the survival of the animal. (auth)

39592 GENETIC CONTROL OF RADIOSENSIVITITY IN E. COLI. Myasnik, M. N. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 10: 262-74(Mar-Apr 1970).

The phenotypic manifestation of the gene fil$^+$ depends both on the condition of culturing and on the genotype in which this gene exists. The frequency of filament formation in the strain E. coli B after irradiation with γ rays or α particles depends on the conditions of preliminary culturing, whereas after irradiation by ultraviolet, there is no such dependence, or it is less pronounced. A correlation is noted between the frequency of filament formation and the ability of the strain for temperature modification of the survival rate. The radiobiological phenotype of the hypersensitive strain E. coli B_{s-1} just as of the strain E. coli B, is determined by the gene fil$^+$; however, the nature of the manifestation of this gene in the strain E. coli B_{s-1} has its own peculiarities, and, in particular, depends on the type of ionizing radiation. In contrast to γ irradiation, after irradiation with α particles the filaments practically are not formed, and there is practically no modifying effect of the conditions of culturing during the post-radiation period. (auth)

39593 EFFECTS OF ULTRAVIOLET IRRADIATION ON HETEROZYGOUS DIPLOIDS OF ASPERGILLUS NIDULANS. II. RECOVERY FROM UV-INDUCED MUTATION IN MITOTIC RECOMBINANT SECTORS. Kaefer, Etta (McGill Univ., Montreal). Genetics; 63: 821-41(Dec 1969).

Ultraviolet treatment of heterozygous diploid, quiescent or germinating, conidia of Aspergillus nidulans was found to produce a high frequency of abnormal, frequently sectoring colonies. In replatings from the abnormal centers of sectoring colonies, the original type could usually be recovered, indicating that the formation of sectors occurred spontaneously. The frequency and type of sectoring was found to be specific for each case and to frequently coincide with a specific type of marker segregation. It is suggested that the abnormal growth of the original colonies is caused by the presence of uv-induced mutations, possibly terminal deletions that are eliminated by subsequent spontaneous mitotic recombination. No evidence for induced segregation that could produce sectoring types was found. Cases with frequent diploid sectors of a single crossover type are interpreted to contain only one mutation in one homologue of the chromosome arm involved. This homologue is usually not recovered in haploids from the original center but parts of it can be isolated in haploids from the diploid segregant sectors. The most complex cases with only haploid sectors may contain more than one mutation in different chromosomes, while stable abnormal types could result from mutations in both homologues of the same chromosome. All eight linkage groups are affected with similar frequency which may indicate that the length of the different chromosomes is fairly similar. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 39144, 39470, 39513, and 39587.

39594 (CEA-R-3980) STERILE MALE TECHNIQUE FOR INSECT SELF DESTRUCTION. Buscarlet, Louis Alphonse (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Apr 1970. 32p. (In French). Dep. CFSTI (U. S. Sales Only).

The sterile male technique makes a rapid and often definitive eradication of the pest population possible. The different research steps, which are necessary to improve the sterile male method, may be divided into both following parts: studies of the radiation effects on insect sterilization; and studies of the sterile population depressive effect on a fertile population involving the various stages connecting theoretical investigations to field application. A table listing 58 species which are part of the control programmes throughout the world indicates the state of progress of the investigations concerned with biology, mass rearing, sterilization by means of irradiation, and population mixing in the laboratory and in the orchards. In this field the French contribution is more particularly represented by studies on Ceratitis, corn borer, and corn weevil. (auth) (France)

39595 (MIT-3343-31) THE EFFECT OF GAMMA RAYS ON MARINE FINFISH FILLETS INOCULATED WITH TYPE E, CLOSTRIDIUM BOTULINUM. Final Report, July 15, 1967–July 14, 1968. Goldblith, S. A.; Nickerson, J. T. R. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-3343. 48p. Dep. CFSTI.

Odor tests for spoilage were done on vacuum-packed nonirradiated and irradiated (100 to 200 krad γ) haddock fillets stored at temperatures ranging from 38 to 50°F. Spoilage times for the 38 and 42°F, 100 krad treated samples were approximately 1.5 longer than that of nonirradiated samples and spoilage times of the 38 and 42°F, 200 krad treated samples exceeded 112 and 84 days, respectively. Counts of aerobic and anaerobic bacteria were done on the spoiled samples and an attempt to identify spoilage bacteria on the spoiled irradiated samples indicated that Aeromonas, Bacillus, Lactobacillus, and Pediococcus were the principal species involved in spoilage. Studies on the toxicity of irradiated and nonirradiated haddock treated in the same way but inoculated with type E Clostridium botulinum showed that the development of toxicity varied among the samples. The content of fats, free sugars, and moisture in haddock, mackerel, and ocean perch was determined and the relation of chemical composition of fish to the growth of clostridium was studied. Results showed that haddock is very low in fats while mackeral is high in fats but low in moisture content. Clostridium growth was slower on haddock than on the other samples. The findings indicate that only heat-shocked spores of type E Clostridium botulinum should be used for the inoculation of fish samples to determine outgrowth and toxin production to prevent positive results caused by toxin present in the inoculum. (C.H.)

39596 (ORNL-tr-2321) EFFECT OF IONIZING RADIATION ON MEAT WITH CONSIDERATION OF VETERINARY HEALTH SANITARY INSPECTION. Kossakowski, Stefan. Translated for Oak Ridge National Lab., Tenn., from Med. Wet. (Poland); 22: 709-14(1966). 13p. Dep. CFSTI.

Induction of radioactivity in meat as a result of β, γ, and neutron irradiation is discussed. It is concluded that the radiation induced in meat as a result of nuclear explosions or reactor accidents is negligible. The concentrations of ^{45}Ca, ^{59}Fe, ^{42}K, ^{24}Na, and ^{32}P in meat following exposure to neutron flux are tabulated. An experiment, operation Teapot, in which meat samples were placed 350 to 1600 m from ground zero is discussed; it was found that the radioisotopes in meat resulting from the explosion decayed rapidly. Radioinduced biochemical changes in meat are discussed with regard to amino acids, proteins, enzymes, carbohydrates, fats, and vitamins. Effects of radiopreservation on toxicity and nutritional values of meats were examined; it was found that the possibility of the presence of toxic and carcinogenic substances in irradiated meat could not be ruled out. (H.L.W.)

39597 (PRNC-135, pp 113-15) INFLUENCE OF GAMMA IRRADIATION ON MANDIOCA FLOUR. Facetti, J. F.; Colman, H. (Asuncion Univ. (Paraguay). Instituto de Ciencias). (In Spanish).

From Radiation and isotope technology in Latin American development.

Results obtained following the irradiation of various mandioca flour samples with ^{60}Co γ rays are reported. Three different samples were studied. Immediate analysis permits classification as very regular, good, and regular. The samples were irradiated in two sources of ^{60}Co with variable doses. A table shows results with respect to the variation in acidity, maltose content, and organoleptic characters. With high doses the organoleptic characteristics were poor. Proliferation by yeast was also observed. Acidity at low doses did not vary with regards to the sample, but at high doses acidity increased with time. The irradiation method may not be used to preserve acidity. The maltose content increases with the dose; in wheat flour a slight increase was also observed. But in the case of mandioca flour the increase was very noticeable. This is very important if the flour is used to make ethanol by fermentation. And since the type of total extractable glucides (fecula) is quite high, mandioca flour is an excellent prime material for obtaining ethyl alcohol. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 39117 and 39677.

39598 (AI-AEC-12948) FUELS, MATERIALS, AND COOLANT CHEMISTRY PROGRAMS. Quarterly Technical Progress Report, January-March 1970. (Atomics International, Canoga Park, Calif.). 15 May 1970. 103p. Dep. CFSTI.

Results of investigations are presented on fuel cladding and structural materials, Na effects on stainless steel, Na reactions with test materials in loops, radiation effects on reactor materials, properties of mixed carbide fuels, Na chemistry, and fission product contamination. (J.R.D.)

39599 (APDA-259) SUMMARY OF THE APDA SODIUM TECHNOLOGY PROGRAM. Meyers, J. E. (Atomic Power Development Associates, Inc., Detroit, Mich.). Jun 1970. Contract AT(11-1)-865. 71p. Dep. CFSTI.

An eight-year sodium technology program conducted in the APDA Sodium Technology Loop is summarized. Development of impurity monitoring devices such as the UKAEA Rhometer, the UNC oxygen meter, the APDA hydrogen detector, and the APDA variable-orifice plugging meter is described along with impurity removal processes such as cold-trapping, hot-trapping, and operation of the APDA-developed sodium centrifuge. Results of investigations of the physical and chemical behavior in sodium of impurities such as hydrogen and sodium carbonate are included. Sampling and analysis procedures, including a sampling reliability study for oxygen and hydrogen; a round robin program for measuring oxygen in sodium; a uranium gettering technique for measuring the oxygen content of sodium; and analytical methods for determining oxygen, total carbon, carbonate carbon, and hydrogen are described. (auth)

39600 (NP-18297(Pt.1)) BIBLIOGRAPHY ON DIFFUSION IN SOLIDS. PART I. DIFFUSION OF SOLIDS IN SOLIDS (1962-1968). Krishnan, A. (comp.) (Bhabha Atomic Research Centre, Bombay (India)). Feb 1970. 376p. Dep. CFSTI (U. S. Sales Only).

A bibliography on diffusion in metals, nonmetals, and solid compounds covering the period from 1962 to 1968 is presented. Methods of study include tracer and chemical diffusion determinations. 1664 references. (J.R.D.)

39601 PROCEEDINGS OF THE TWENTH-FIFTH ANNUAL POWDER METALLURGY CONFERENCE, NEW YORK, MAY 5-7, 1969. Progress in Powder Metallurgy. Volume 25. New York; Metal Powder Industries Federation (1969). 145p. $12.00. (CONF-690550).

Papers presented at the conference are concerned with high performance superalloys; non-ferrous powder metallurgy materials; production of strip, rod, and wire by powder metallurgy; properties of powder metallurgy steel; high strength powder metallurgy materials; iron-base dispersions with Cu, Ni, and C; Al powder metallurgy; and the outlook for powder metallurgy. (J.R.D.)

Corrosion and Erosion

Refer also to abstracts 38833 and 38884.

39602 (AECL-3612) ENVIRONMENTALLY INDUCED CRACKING OF ZIRCONIUM ALLOYS. II. LIQUID METAL EMBRITTLEMENT. Cox, B. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). May 1970. 19p. Dep. CFSTI (U. S. Sales Only). AECL $1.00.

Zirconium, Zircaloy-2 and other zirconium alloys undergo transgranular cracking in mercury, but not in liquid cesium, at room temperature, when specimens are deformed during immersion until the protective oxide cracks. Wetting of the zirconium alloy by the mercury is followed almost instantaneously by fracture of the specimen. Cracking could not be achieved in specimens bearing an oxide film thicker than the normal film formed in air on a pickled surface (30 to 60 Å). This is presumably because the liquid metal does not wet the zirconium oxide film and is therefore unable to enter the cracks produced in these thicker films and hence to wet the metal. Cracking is also difficult in very ductile specimens of crystal-bar zirconium, showing that blunting of an initial notch may be as important as surface wetting in achieving embrittlement. (auth)

39603 (AI-AEC-12952) DEPOSITION OF CESIUM AND BARIUM IN A SODIUM-STAINLESS STEEL SYSTEM. Guon, J. (Atomics International, Canoga Park, Calif.). 30 Jun 1970. Contract AT(04-3)-701. 78p. Dep. CFSTI.

Quantitative results have been obtained on the deposition of cesium and barium in a sodium-stainless steel system. For the first time, sufficient detail has been obtained to predict, with some confidence, the distribution of fission product cesium and barium released to a Liquid Metal Fast Breeder Reactor (LMFBR) system as a result of fuel cladding failure. Some insight has been developed into the processes occurring during deposition. (auth)

39604 (AWRE-O-18/70) THE IDENTIFICATION OF THE PROTECTIVE OXIDE FILM FORMED ON A Co-Cr-Mo ALLOY. Hughes, A. N.; Lane, R. A. (Atomic Weapons Research Establishment, Aldermaston (England)). Jun 1970. 13p. Dep. CFSTI (U. S. Sales Only). UK 2s.

Production of oxide films is described and results of analyses are included. The film is thought to be mostly Cr_2O_3 mixed with a smaller quantity of Co_2O_3. (J.R.D.)

39605 (EUR-4000) DEVELOPMENT WORK ON STRESS-CRACKING CORROSION OF STAINLESS STEELS. Montuelle, J.; Cunha Belo, M.; Berge, Ph.; Colin, D. (Centre National de la Recherche Scientifique, Paris (France)). May 1969. 22p. (In French). (EURAEC-2064). Dep. CFSTI (U. S. Sales Only).

Cracking in stainless steels under mechanical stress in boiling magnesium chloride is caused by the prior formation of a thin film of passivating oxide; it was possible to establish this point mainly by means of electron microscopy and electrochemical techniques. The role of certain factors relating to the corrosive medium was demonstrated: certain specific impurities can considerably affect the length of the incubation period (i.e., the period preceding inception of cracking). By means of the study of high-purity alloys, of which it is known that austenite is liable to change into martenite during cooling to a greater or lesser degree, it was possible to determine that immunity to stress corrosion of stainless steels with austeno-martensitic structure could be achieved by a purely electrochemical technique. (auth)

39606 (NP-9870) THE OXIDATION OF SOLID FISSION PRODUCTS IN THE HELIUM PURGE FLOW. Project DRAGON. Romberg, E. (Atomic Energy Establishment, Winfrith (England)). Jan 1961. 12p. (DP-Report-13). Dep. CFSTI.

The possibility of forming SrO and BaO in the purge flow by reaction of the metals with CO and CO_2 was confirmed. (auth)

39607 SULPHIDATION OF CHROMIUM AND SOME CHROMIUM-MOLYBDENUM ALLOYS: KINETIC AND MORPHOLOGICAL FEATURES OF THE PROCESS. Strafford, K. N.; Hampton, A. F. (Liverpool Univ.). J. Less-Common Metals; 21: 305-24(Jul 1970).

The sulfidation behavior of pure Cr and several Cr-Mo alloys, containing between 0.01 and 1.0 wt % Mo, has been studied in the temperature range 850 to 1000°C, in hydrogen/hydrogen sulfide atmospheres of different compositions, chosen to give a standard sulfur activity corresponding to $pS_2 = 0.8$ torr for this temperature range. The reaction kinetics observed with all of the materials in this temperature range were parabolic. The rate of sulfidation of pure Cr has been shown to be very rapid, being several orders of magnitude faster than the rate of corrosion in air, oxygen or nitrogen. Increasing additions of Mo to Cr progressively reduced the rate of attack at all temperatures, and the alloy containing 1% Mo corroded at about ×0.70 to ×0.76, the rate for pure Cr, depending upon reaction temperature. The rate constant for all materials decreased with decreasing temperature, and the activation energy for the corrosion process was about 34 to 38 kcal mol^{-1}, irrespective of composition. The morphology of the scales was complex, in general both single- and double-layered scales being observed, but a number of interesting features, which were evident, could be systematically related to the experimental variables of exposure time and composition of the alloy, at given reaction temperatures. The probable mechanism(s) of sulfidation of pure Cr and the Cr-Mo alloys are considered. (auth)

39608 NEW CORROSION RESISTANT MATERIALS FOR HYDROCHLORIC ACID SOLUTIONS. Chekhovskii, S. V.; Andreeva, V. V.; Konstantinov, V. I.; Orlov, V.; Netupskii, I. V.; Klinov, I. Ya. Khim. Neft. Mashinostr.; No. 4, 21-3(1968). (In Russian).

Alloying zirconium with tantalum (>40 at. % Ta) completely eliminates the susceptibility of zirconium to pitting corrosion in all HCl solutions. The link between initiation of pitting cor-

rosion and a specific potential value suggests the possibility of electrochemical protection. (Referativnyi Zh.)

Preparation and Fabrication

Refer also to abstracts 39167, 39181, 39192, 39202, and 41058.

39609 (DP-Report-68) CODE OF PRACTICE FOR CLEANING AND CORROSION PROTECTION OF HEAT DISPOSAL AND AUXILIARY CIRCUITS OF THE DRAGON REACTOR. Project DRAGON. Conde, J. F. G. (Atomic Energy Establishment, Winfrith (England)). Nov 1961. 15p. Dep. CFSTI.

The cleaning procedure for the various auxiliary circuits of DRAGON is detailed and the corrosion inhibition precautions specified. The code gives instructions governing components and materials and relates the protection measures to the specific circuits. (auth)

39610 (DP-Report-198) ELECTRON BEAM WELDING EXPERIMENTS FOR BURSTING DISC ASSEMBLIES. Project DRAGON. Hansen, R. (Atomic Energy Establishment, Winfrith (England)). Jun 1963. 28p. Dep. CFSTI.

Attempts to electron beam weld very thin discs to solid slugs as part of the special bursting disc assemblies required for the Dragon reactor helium purification plant are described. These assemblies have a leak rate of $<10^{-8}$ atmospheric cm^3/S and burst at a pressure of 24 atmospheres. Discs of nickel and silver were used with holders of stainless steel and Monel 400. (auth)

39611 (ORNL-tr-2326) PROPERTIES OF ULTRAFINE TUNGSTEN POWDER. I. Yamamoto, Hiroshi; Ueki, Kazuyoshi; Ichiyama, Noboru. Translated for Oak Ridge National Lab., Tenn., from Funtai Oyobi Funmatsuyakin; 15: No. 4, 174-83(1968). 22p. Dep. CFSTI.

The preparation and properties of ultrafine powders of tungsten, tungsten 18.7% rhenium and thoriated tungsten (4.4% ThO_2) are described. The preparation consists of two processes, freeze-drying and reduction with hydrogen at relatively low temperature. According to the desired powder composition, the solution of ammonium paratungstate, the mixed solution of ammonium paratungstate and ammonium perrhenate or the solution of thorium nitrate suspending the fine particles of tungstic acid were frozen rapidly and dried under the reduced pressure through sublimation. The products thus obtained consist of fine particles having a mean diameter of 0.3 to 3 microns. The more rapidly the solution was frozen, the finer the particles became. Freeze-dried powders were reduced with hydrogen at 300 to 800°C. Metal particles of tungsten or tungsten alloy were obtained above 600°C, and the mean diameter was 0.02 to 0.1 microns. Inter-particle sintering was observed at higher reduction temperatures, resulting in larger particles. (auth)

39612 METHOD OF TREATING SURFACES OF ZIRCONIUM ALLOY TUBES. (to Westinghouse Electric Corp.). British Patent 1,196,060. 24 Jun 1970. Priority date 30 Oct 1967, United States.

A method for mechanical preparation of Zircaloy tubing for surface corrosion passivation is described. The surfaces are abraded to a coarse surface first, followed by abrasion to a finer surface having a Knoop hardness of over 2000. The treatment serves to remove any contamination from as-received material. (J.R.D.)

39613 WELDING PROCESS. (to Nukem Nuklear-Chemie und Metallurgie Gesellschaft mbH). British Patent 1,196,839. 1 Jul 1970. Priority date 14 Sep 1967, Germany.

A method for weld filler electrodeposition initiation without contact in tungsten inert-gas welding is described. The open circuit voltage of the welding system is increased to about three times the welding voltage during the initiation period. Helium is used as the welding atmosphere. (J.R.D.)

39614 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. Juni 1970. Band 4, Heft 6. 192 Referate (Register-Nr. 1789-2137). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. June 1970. Vol. 4, No. 6. 192 Abstracts (Register No. 1789-2137)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H. (1970). 110p. (In German and English).

39615 PREPARATION OF THORIUM METAL BY FUSED SALT ELECTROREFINING OF THORIUM CARBIDE. Yoshida, Susumu; Ayano, Tetsuo; Kuroda, Tadashi (Tokyo Inst. of Tech.). Denki, Kagaku; 38: 433-6(Jun 1970). (In Japanese).

Fused salt electrorefining of thorium was carried out with thorium carbide as an anode to develop processes for preparation of pure thorium metal and for a reprocessing of ThC_2 reactor fuel. Tablets of ThO_2 and carbon mixtures (molar ratio $C/ThO_2 = 4$) were sintered in an evacuated state ($<10^{-1}$ mmHg) at about 1300°C for 3 hours. The efficiency of ThC_2 formation was about 95%. The electrolysis was carried out with $ThCl_4$ – NaCl + KCl (eq. mol) melt, and a molybdenum rod cathode of 3 mm in diameter in argon atmosphere. High purity thorium metal was obtained. The electrolysis was carried out without bath decomposition, ThC_2 anode passivation, and bath contamination with carbon were not observed in the procedure. (auth) (Japan)

39616 LIQUID-PHASE SINTERING. Eremenko, V. N.; Naidich, Yu. V.; Lavrinenko, I. A. New York; Plenum Publishing Corp. (1970). 81p. (NP-tr-1911).

Translation of Spekanie v Prisutstvii Zhidkoi Metallicheskoi Fazy.

Liquid-phase sintering processes and the action of capillary forces are examined in models of dispersed solid-liquid systems. Data from theoretical and experimental studies of liquid-phase sintering in various metal and metal-ceramic systems are included. (J.R.D.)

39617 HOT PRESSING OF MOLYBDENUM POWDER. Samsonov, G. V.; Kovalchenko, M. S.; Petrykina, R. Ya.; Grechishkina, N. P. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 46-9(May 1970). (In Russian).

The sintering of technically pure molybdenum powder with particle size 2 to 15 μm is studied by hot pressing within the range of temperatures 1400 to 1600°C. Optimum conditions for obtaining the compact articles is determined. The activation energy is determined of the process of molybdenum powder sintering by hot pressing. This energy is compared with that of niobium activation. Difference in energy values of these metals' activation is conditioned by the difference in statistical weight of atoms with the stable configurations d^5. (auth)

Properties Evaluations

Refer also to abstracts 39138 and 40949.

39618 (AWRE-O-34/70) HIGH STRENGTH URANIUM ALLOYS. MECHANICAL PROPERTIES. Willows, R.; Whitlow, G. A. (Atomic Weapons Research Establishment, Aldermaston (England)). May 1970. 19p. Dep. CFSTI (U. S. Sales Only). UK 3s. 0d.

The effects of heat treatment by quenching and aging on the Vickers diamond hardness of Cr–U, Mo–U, and U alloys were investigated. The additions of 0.1 to 0.5% Al, Mo, Nb, Si, or Sn had little effect on the hardness of these alloys. The effects of time and temperature on the tensile properties of solution treated and aged Mo–U alloys were studied. The hot working properties of Mo–U alloys, previously reported, are summarized. (G.M.C.)

39619 (CEA-CONF-1516) MEASUREMENT OF PARTIAL DEGASSING FLUXES IN MOLYBDENUM AND TUNGSTEN AT 2000°K. Lesueur, Robert (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 10p. (In French). (CONF-700418-1). Dep. CFSTI (U. S. Sales Only).

From Symposium on Metrology and Analysis of Gas in Ultra-High Vacuum, Paris, France.

Partial degassing fluxes are measured at 2000°K for four molybdenum samples (three are vacuum melted and the last one sintered) and two tungsten samples (the first one sintered and the other deposited on Mo by WF_6 pyrolysis). A double calibration is effected in order to measure the pumping rate in the sample for each gas and the partial pressures at the same point. The device described comprises an electron microscope as a cell. The degassing time and the contents of the samples in gaseous impurities (H_2, CH_4, N_2, CO, O_2, CO_2) are evaluated in order to compare and choose specific materials for use in specific applications. (auth) (France)

39620 (CONF-691208-(Vol.1), pp 53-61) PROPERTIES OF TRANSURANIC METALS. Mendelssohn, K. (Oxford Univ. (England). Clarendon Lab.).

Studies of metallic plutonium and neptunium have shown a number of interesting features in the series of actinide elements which, to some extent, bears a relation to the rare earth metals. Studies at low temperatures revealed a number of new and interesting effects. The effects can be divided into two groups. The first concerns the physical equilibrium properties of the metal which, to some extent, are highly anomalous while the second group consists of the changes which these equilibrium properties undergo under prolonged self irradiation at low temperatures. These changes, in turn, permit certain conclusions

to be drawn concerning the nature of the equilibrium anomalies. In spite of the considerable amount of experimental data on these metals, it should be realized that a satisfactory understanding of this interesting series is yet to be realized. The work described consists essentially of the results, obtained during the last ten years, in a joint research program undertaken by the University of Oxford and the Atomic Energy Research Establishment, Harwell. (auth)

39621 (CONF-700403-6) HEAT CAPACITY OF SCANDIUM FROM 6 TO 350°K. Gerstein, B. C.; Taylor, W. A.; Shickell, W. D.; Spedding, F. H. (Ames Lab., Iowa). [1969]. 24p. Dep. CFSTI.

From 8th Rare Earth Conference, Reno, Nev.

The heat capacity of scandium was measured from 6 to 350°K. The results differ from previous measurements in this temperature range by more than the accuracies of the measurements. The difference is discussed in terms of impurity effects. The thermodynamic functions are tabulated for the range studied. (auth)

39622 (DP-Report-71) EMISSIVITY REPORT. PART I. DEVELOPMENT OF APPARATUS AND TECHNIQUES FOR THE MEASUREMENT OF SPECTRAL EMISSIVITIES WITH SOME PRELIMINARY DATA ON NICKEL, NILO 40, AND PYRISTA STAINLESS STEEL. Project DRAGON. Stillwell, J. C. (Atomic Energy Establishment, Winfrith (England)). Dec 1961. 27p. Dep. CFSTI.

The prototype apparatus was used to study improvements in design and measurement. As a result a second rig was built which was more versatile, and already temperatures were achieved in excess of those possible with the original. A specimen of tubular shape, incorporating a small hole as a black body source was chosen initially for both metals and graphite and this design was retained throughout with modifications to aid manufacture. The standard specimen which was adopted had a central tube 2½" long into which solid electrodes were brazed at either end. A critique of measurement showed that improvement in specimen design with particular attention to the achievement of a uniform temperature surrounding the black body would lead to an improvement of 9 to 13% in the uncertainty of emissivity values for machined specimens. Such specimens were produced and are being tested. (auth)

39623 (DP-Report-80) THE METALLURGICAL PROPERTIES OF THE DRAGON REACTOR PRESSURE VESSEL. Project DRAGON. Conde, J. F. G. (Atomic Energy Establishment, Winfrith (England)). Jan 1968. 112p. Dep. CFSTI.

The metallurgical properties of the Dragon Reactor pressure vessel and primary heat exchanger pressure casing materials are detailed and discussed. It is concluded that the properties are adequate for the projected service life of 20 years under normal operating conditions. (auth)

39624 (DP-Report-84) THE MEASUREMENT OF HIGH TEMPERATURES BY THE DETERMINATION OF THE VELOCITY OF SOUND WAVES IN MATERIALS. Project DRAGON. Thorne, E. A.; Mobsby, E. G. H. (Atomic Energy Establishment, Winfrith (England)). Jan 1962. 13p. Dep. CFSTI.

The results of the examination of several materials considered as probe materials for the measurement of high temperatures by the determination of the velocity of sound in materials is described. Molybdenum was found to be the most promising of the five materials investigated. (auth)

39625 (DP-Report-101) THE COMPATABILITY OF SOME GASKET MATERIALS WITH MILD STEEL AT 300°C (Ag,Al) AND STAINLESS STEEL AT 450°C (Cu,Ni). Project DRAGON. Horsley, G. W.; Hedman, B. H. (Atomic Energy Establishment, Winfrith (England)). Jun 1962. 14p. Dep. CFSTI.

Experiments carried out with aluminum and silver gaskets compressed between gramophone grooved, mild steel flanges showed no signs of seizure either in neutral or reducing atmospheres at 300°C. For practical reasons a thick silver gasket on a deep grooved flange was superior to a shallow grooved flange and thin gasket. Compatibility tests on stainless steel/copper and stainless steel/nickel in air and vacuum demonstrated that both copper and nickel were suitable as demountable gasket materials in contact with stainless steel at 450°C. In oxidizing atmospheres nickel was preferable, as copper tended to seize due to oxide formation. In the reducing conditions in the Dragon reactor, both metals should be equally applicable as gasket materials at 450°C, provided that in case of copper, oxygen-free material is employed. (auth)

39626 (DP-Report-187) THERMAL EMISSIVITY OF SOME HIGH TEMPERATURE MATERIALS. Project DRAGON. Stillwell, J. C. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 21p. (CONF-630511-27). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

Results of experiments conducted to determine the emissivity of stainless steel, Nilo 40, and graphite are presented. (J.R.D.)

39627 (IN-1378) SECHT-IV: PERFORMANCE EVALUATION OF STAINLESS STEEL- AND ZIRCALOY-CLAD ELECTRICALLY POWERED HEATERS. Plum, J. L. (Idaho Nuclear Corp., Idaho Falls). Jun 1970. Contract AT(10-1)-1230. 49p. Dep. CFSTI.

The Scoping Emergency Cooling Heat Transfer (SECHT) Project was a parametric experimental study of bottom and top flooding modes of emergency core cooling for nuclear fuel assemblies. Four series of tests were conducted using electrically powered heaters to simulate nuclear fuel pins. Heaters for the first three series were clad with relatively inexpensive stainless steel. Zircaloy, the normal cladding material for nuclear fuel pins, was used as the cladding for heaters utilized for the SECHT-IV series of tests described in this report. This series consisted of a limited number of tests conducted to obtain thermal-response data from Zircaloy-clad heaters operated at conditions similar to those of selected tests of the SECHT-III series. Tests were conducted at different initial cladding temperatures ranging from 1000 to 1800°F; all other parameters of interest were held constant. Data from comparable tests of the two series were used to evaluate the relative thermal response of heaters clad with the two different materials but otherwise identical. This evaluation verified that for initial cladding temperatures up to 1800°F, stainless steel may be substituted for Zircaloy as a cladding material for electric heaters to be used as simulators for nuclear fuel pins. (auth)

39628 (KAPL-Trans-3) QUESTIONS IN THE THEORY AND TECHNIQUE OF WELDING NIOBIUM- AND NICKEL-BASE HEAT-RESISTING ALLOYS. Erokhin, A. A.; Shorshorov, M. Kh.; Chernyshova, T. A. Translated for Knolls Atomic Power Lab., Schenectady, N. Y., from pp 145-53 of Fiziko- Khimicheskie Issledovaniya Zharoprochnykh Splavov, Izdatel'stvo, Nauka, Moscow, 1968. 16p. Dep. CFSTI.

This paper was abstracted from the original language and appeared in NSA as 24: 14764. (J.R.D.)

39629 (MSAR-70-54) THE EFFECT OF HIGH-TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. TECHNIQUES FOR MONITORING HIGH CARBON ACTIVITY SODIUM: AN EVALUATION OF THE UNC CARBON METER. Topical Report No. 16. Rodgers, S. J.; Shreve, R. J. (MSA Research Corp., Evans City, Pa.). May 1970. Contract AT(11-1)-765. 97p. (XAC-720452). Dep. CFSTI.

Techniques for monitoring carbon as a contaminant in sodium are discussed. Monitoring tabs, plugging-indicator curves, and chemical analyses, while useful techniques in system operations, did not provide either an instantaneous or a continuous method for monitoring carbon or, more importantly, carburization potential. The UNC carbon meter is the newest monitoring technique. The results of the first field test appeared most promising. The carbon meter output can be related to carburization of austenitic steels. The problems associated with the installation and operation of the UNC carbon meter are discussed. The problems included instrument operation, gas flow control, and measurement and control of moisture content in the gas. The adjustment of carbon activity level and its maintenance by control of the temperature and flow parameters in a bed of graphite rods is presented. A calibration curve of the carbon meter output against the carburization of 5-mil, 304 stainless steel tabs was accomplished. Calibration curves for both 48- and 168-hour exposures were determined. The curves represented two different locations in the system and were not interchangeable. The carbon activity level, as measured by the carbon meter, was affected by system operations and conditions. Among these are tab insertion and removal, plugging indicator operation, and cold trap operating conditions. A preliminary study of the relationship of carburization of 304 stainless steel with time was undertaken. Curves for two tab thicknesses with exposures up to 336 hours were determined. (auth)

39630 (MSAR-70-76) EFFECT OF HIGH-TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. Final Report. Kirschler, L. H.; Hiltz, R. H.; Rodgers, S. J. (MSA Research Corp., Evans City, Pa.). May 1970. Contract AT(11-1)-765. 216p. Dep. CFSTI.

High oxygen-sodium and carbon-sodium excursions of Type 304 and 316 stainless steels at 1200 and 1400°F were completed, followed by creep-rupture testing in high velocity clean sodium and tensile tests in air. Creep rupture properties of these steels in clean dynamic sodium were tested following long-term exposures in clean static sodium. Tensile tests in air were also conducted. Tensile tests and metallurgical studies were completed of 6 candidate ferritic steel alloys exposed to decarburizing static sodium

environment. Vanadium alloys were metallographically examined after sodium exposure. The super-plastic alloy, IN-744, and U. S. Steel alloy 18–18–2, were exposed to three separate sodium environments, followed by tensile tests and metallographic studies. A linear variable differential transformer type of extensometer was developed and successfully tested in 1200°F sodium. Attempts were made to measure and evaluate the effects of oxygen on the surface tension of sodium. The first UNC carbon meter and UNC oxygen meters were field tested and calibrated. (G.M.C.)

39631 (NP–18289) SELF-WELDING OF REACTOR STRUCTURAL MATERIALS UNDER SODIUM AT HIGH TEMPERATURES. Benndorf, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Apr 1970. 39p. (In German). Dep. CFSTI (U. S. Sales Only).

The self-welding tendency of structural materials was investigated by static load tests in sodium. Besides austenitic materials also a stabilized ferritic steel and a nickel base alloy as well as several hard facing and hard metal alloys were tested. The test temperatures were 580 and 700°C, the compressive load ranged up to 5 kg/mm², and the tests lasted for 168 hrs. The oxygen content of the cold-trapped sodium was nearly 20 ppM. The results show a more or less pronounced tendency of all the materials to weld together. While the austenitic and ferritic steels showed a marked tendency to weld together at 700°C, the behavior of the hard facing and the hard metal alloys was not uniform. The nickel base alloy, which up to now was investigated in one experiment only, did not weld together–with one exception. Micrographs made of some different material combinations seem to indicate that the welding was caused by recrystallization after previous strong deformation of the contact region. (auth)

39632 (NRL–7056) DYNAMIC TEAR TEST INVESTIGATIONS OF THE FRACTURE TOUGHNESS OF THICK-SECTION STEEL. Heavy Section Steel Technology Program Technical Report No. 7. Loss, F. J. (Naval Research Lab., Washington, D. C.). 20 Jan 1970. 54p. (HSSTP-TR-7). Dep. CFSTI.

The effect of mechanical constraint imposed by thick sections was examined in the framework of linear elastic fracture mechanics (LEFM) and other temperature-transition indices. Extrapolation of thin-section LEFM data to higher temperatures raised the concern that thick-section steels, of shelf toughness and strength class similar to A533-B, will not exhibit a brittle-to-ductile transition with increasing temperature. Research programs relating to thick dynamic tear (DT) test studies and to thick LEFM investigations showed that unirradiated A533-B exhibited a significant increase in toughness within a relatively narrow temperature region near the nil ductility transition (NDT) temperature. Size effects studies indicated that the effects of mechanical constraint associated with thick sections elevated the fracture transition–elastic (FTE) temperature (the temperature at which very large flaws remain dormant up to yield stress) for 12-in.-thick sections approximately 70°F above the FTE temperature for thin sections, which in turn is 60°F above the NDT temperature. For the steels investigated the DT energy curve may be divided into three toughness regimes which are shown to indicate similar transition features for specimens of ⅝-in. to 12-in. thickness. Regime 1 defined a temperature interval of rapidly increasing dynamic LEFM fracture toughness which eventually rendered this technique inapplicable with small increases in temperature. Regime 3 represented fractures exhibiting large plastic deformation for which suitable fracture mechanics analyses were not yet developed. Regime 2 defined a transition between the two extreme cases in which nominal stresses above yield level become necessary to propagate fracture. The midpoint energy, located in this regime, is defined as the FTE for steels of A533 toughness level. (auth)

39633 (WANL-TME–1106) MECHANICAL AND PHYSICAL PROPERTIES OF VACUUM HOT PRESSED AND EXTRUDED BERYLLIUM. Nadler, R. A. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). 15 Feb 1965. 24p. Dep. CFSTI.

An analysis of the chemical, physical, and mechanical properties was made of beryllium procured for outer reflector components of the first four NRX reactors. With but a few exceptions, all parts accepted met the property requirements of WANL PDS 30034 (extruded beryllium) or WANL PDS 30018 (vacuum hot pressed beryllium). An investigation of the effects of density variations on mechanical properties showed that properties were degraded when density was below the specification minimum of 1.84 g/cm³. In addition, an excellent correlation was obtained between density and the intensity of fluorescent penetrant indications. Thermal expansion data are reported for both pressed and extruded beryllium, and a 10 to 15% difference in the coefficient of expansion is shown to exist between the longitudinal and transverse direction of extruded metal. Because of some disagreement in the expansion data reported by several investigators for hot pressed beryllium, some additional work is indicated for this area. (auth)

39634 (ZJE–77) HEAT TREATMENT OF STEEL COMPONENTS IN WATER–AIR DISPERSION. Kotrc, S. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 9p. Dep. CFSTI (U. S. Sales Only).

A description of heat treatment of large steel components of the A-1 power station pressure vessel by accelerated cooling with a water–air mixture is given and compared with the cooling by the classical cooling media (water, air, oil). Special emphasis is given to methods for the acceleration of cooling and to the cooling efficiency of water–air mixture. (auth)

39635 RELIABILITY EVALUATION OF BRITTLE MATERIALS AND OF WELDED STRUCTURES. Basile, D.; Musso, G.; Volta, G. (CCR–EURATOM, Ispra, Italy). Met. Ital.; 62: 102-9(1970). (In Italian).

The theory of reliability applied to material resistance is discussed. A critical review is given of parameters used to characterize materials and structures (allowable stresses, elongations, impact properties, and fracture toughness) connected to different load conditions. The methods for a statistical computation of safety factors are introduced. The theory is applied to a zirconium alloy pressure tube for a nuclear reactor in which peculiar embrittling problems exist due to the presence of welds, intermetallic joints, and hydriding corrosion. (auth)

39636 TRACER DIFFUSION DATA FOR METALS, ALLOYS, AND SIMPLE OXIDES. Askill, John. New York; Plenum Publishing Corporation (1970). 113p. $12.50.

Information on diffusion is presented in chapters on diffusion coefficients and mechanisms of diffusion, empirical and semi-empirical diffusion relations, and radioactive tracers for diffusion. A separate abstract was prepared for the chapter on radioactive tracer uses. (J.R.D.)

For an abstract of one chapter see: 39637.

39637 RADIOACTIVE TRACER DIFFUSION DATA IN METALS, ALLOYS, AND OXIDES. pp 27-81 of Tracer Diffusion Data for Metals, Alloys, and Simple Oxides. /Askill, John. New York; Plenum Publishing Corporation (1970).

A compilation of all radioactive tracer diffusion data for pure metals, alloys, and simple oxides is presented. The data are divided into four parts and presented in pure metals, impurity diffusion in pure metals, self-diffusion and impurity diffusion in alloys, and self-diffusion and impurity diffusion in simple metal oxides. (J.R.D.)

39638 ADSORPTION OF OXYGEN ON THE (110) PLANE OF TUNGSTEN. Kohrt, Carl; Gomer, Robert (Univ. of Chicago). J. Chem. Phys.; 52: 3283-94(15 Mar 1970).

The sticking coefficients and desorption kinetics of oxygen on a (110) tungsten crystal have been investigated by a step desorption/reflection technique. Sticking coefficients follow a generalized Kisliuk model, if allowance for reflection on first impact with the surface is made. Unlike CO on (110) W, reflection of O_2 is appreciable and appears to have an activation energy of 0.6 kcal, with respect to substrate temperature. Desorption follows first-order kinetics and has an activation energy of ~92 kcal. The process is complex, however, as shown by the variation in pre-exponential with surface treatment. A mechanism involving the formation and subsequent decomposition of two distinct surface oxide phases is postulated and shown to fit the experimental results. On the basis of this mechanism the observed activation energy corresponds to the process oxide → mobile adsorbed O, and it is shown that this implies an upper limit of 126 kcal for the heat of adsorption of O atoms on (110) W. (auth)

39639 NUCLEAR REACTOR FUEL. Lass, James Lloyd; Smith, Bart Alan (to General Electric Co.). British Patent 1,197,328. 1 Jul 1970. Priority date 14 Oct. 1966, United States.

The design of fuel pellets is described in which two cavities are incorporated to accept the plastic flow occurring in the pellets at reactor operating temperatures. The cavities volume can be varied at fabrication time depending on the anticipated exposure. Cavity configurations are described. (J.R.D.)

39640 YIELD STRESS IN NIOBIUM–NITROGEN SOLID SOLUTIONS. Szkopiak, Z. C. (Univ. of Surrey, Eng.). J. Less-Common Metals; 21: 383-93(1970).

The yield point and associated parameters were studied in electron beam-refined niobium containing amounts of nitrogen ranging from 60 to 850 wt ppM, tested at room temperature and strain rates from 1×10^{-4} to 1.3×10^{-1} sec^{-1} The upper and lower yield stresses and the lattice friction stress showed three

stages of solution hardening, while the yield point drop and the k_y parameter showed one stage only. A comparison of solution-hardening coefficients of the present niobium–nitrogen alloys with those for niobium–oxygen alloys showed that nitrogen was twice as effective as oxygen as a solution hardener. The solution-hardening coefficients for the upper- and lower yield stresses and the lattice friction stress decreased while those for the yield point dropped and the k_y parameter increased with increasing strain rate. The yield point and associated parameters exhibited similar strain rate dependence to that previously observed in niobium–oxygen alloys. The dislocation velocity exponent (m), as calculated from the strain rate dependence of the upper and lower yield stresses using the equation $\log \sigma = \log B + (1/m) \log \dot{\epsilon}$, showed a relationship with nitrogen concentration (C) of the form, $m = m_0 + \beta C^{1/3}$. (auth)

39641 THERMODYNAMICS OF DILUTE SOLUTIONS OF CERIUM IN LIQUID MAGNESIUM. Bayanov, A. P. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 91-3(1970). (In Russian).

The values of the activity coefficients, excess partial molar free energy, entropies, and enthalpies of dilute solutions of cerium in liquid magnesium were calculated at 973 to 1073°K. Solutions of cerium in liquid magnesium are characterized by strong negative divergence from the Pauli principle and do not possess the properties of regular solutions. (tr-auth)

39642 INFLUENCE OF NITROGEN AND OXYGEN ON THE YIELD STRESS OF NIOBIUM. Elssner, G.; Hoerz, G. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Less-Common Metals; 21: 451-5(1970).

To obtain more detailed information on the interstitial solid solution hardening of niobium, the dependence of the lower yield stress on the nitrogen and oxygen content was investigated at room temperature for gas concentrations up to 1 at. %. The effect of oxygen on the yield stress of niobium was determined at deformation temperatures of −73 to +90°C. (G.M.C.)

39643 RECRYSTALLISATION OF NIOBIUM. Thompson, S. J.; Flewitt, P. E. J. (Central Electricity Generating Board, Berkeley, Eng.). J. Less-Common Metals; 21: 456-8(1970).

The recrystallization temperatures for controlled-purity niobium (50 ppM O_2) were obtained for various deformations and times of anneal. The lowest temperature at which recrystallization occurred was 0.34 T_M. A hardness method was used to follow the recrystallization process. (G.M.C.)

39644 TEMPERATURE DEPENDENCE OF YIELD AND FRACTURE IN β-PHASE NIOBIUM–25 PERCENT ZIRCONIUM. Palmer, D. E. B.; Flewitt, P. E. J. (Central Electricity Generating Board, Berkeley, Eng.). J. Less-Common Metals; 21: 459-62(1970).

Results of the temperature dependence of the yield and fracture stress for a β-phase niobium–25% zirconium alloy are described and critically compared with values for pure niobium. The tests were performed at a constant strain rate of 3.7×10^{-3} at 4.2 to 1000°K and taken to failure. (G.M.C.)

39645 MECHANICAL PROPERTIES OF POLYCRYSTALLINE YTTERBIUM FROM 78° TO 525°K. Owen, C. V.; Scott, T. E. (Ames Lab., Iowa). J. Less-Common Metals; 21: 427-36(1970).

The flow-stress temperature dependence, strain-hardening exponent, strain-rate sensitivity, and ductility of ytterbium were determined from 78 to 525°K at strain rates of 0.005, 0.01, 0.1, and 1.0 min^{-1}. The effects of polymorphic phase transformation and dynamic strain aging on these properties are discussed. (auth)

39646 ERMAL CONDUCTIVITY. Proceedings of the Eighth Conference Held at West Lafayette, Indiana, October 7-10, 1968. Ho, C. Y.; Taylor, R. E. (eds.). New York; Plenum Press (1969). 1189p. $40.00. (CONF-681009).

A separate abstract was prepared for each of 17 papers. The remaining papers were not within scope of NSA. (M.O.W.)

For abstracts of individual papers see: 39647–39652, 39671, 39672, 39706–39711, 39736, 40056, and 40071.

39647 THERMAL CONDUCTION IN MERCURY AT LIQUID HELIUM TEMPERATURES. Bhagat, S. M.; Serlemitsos, A. T. (Univ. of Maryland, College Park). pp 165-73 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

Measurements are reported on the thermal conduction in polycrystalline samples of high-purity mercury at liquid helium temperatures, both in the normal and the superconducting states. The data on samples grown under a variety of circumstances can be summarized as follows: (a) the conductivity in the normal state, λ_n, can be described by an expression of the form $AT^{-1} + B$, where B is negative and much smaller than A. (b) For temperatures very close to the transition point λ_s/λ_n can be expressed as $(T/T_c)^n$ with $7 < n < 9$. (c) Whereas the temperature dependences are repeatable, the magnitude of the conductivity changes considerably from one specimen to another. It is suggested that the present measurements are the first indications of an anisotropic thermal conduction in mercury at helium temperatures. The temperature dependences of λ_s and λ_n are explained qualitatively by taking into account low-lying peaks in the phonon density of states of mercury. (auth)

39648 THERMAL RESISTIVITY OF CADMIUM AND CADMIUM–ZINC. Bogaard, R. H.; Gerritsen, A. N. (Purdue Univ., Lafayette, Ind.). pp 185-90 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

The thermal intrinsic resistivity (W_i) of Cd single crystals (resistance ratio = 4×10^4 at 1.5°K) was measured from 2.5 to 15°K for both hexagonal and basal directions. Two Cd–Zn single crystals (Zn concentrations of the order of 0.1 and 0.6 at. %, resistance ratio = 3×10^3 and 500, respectively) have also been measured. The data can be represented by $W \alpha T^n$. For the purest crystal, n = 4.5 for temperatures between 4 and 7°K, and n = 2.2 for temperatures between 3 and 13°K for the crystal with the highest concentration of Zn. The known, rapid change of the specific heat Debye temperature below 10°K is not sufficient to explain the large n observed here. (auth)

39649 THERMOPHYSICAL PROPERTIES OF HOT-PRESSED BERYLLIUM. Tye, R. P.; Brazel, J. P. (Dynatech Corp., Cambridge, Mass.). pp 315 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

The thermal conductivity, electrical resistivity, and heat capacity of a number of samples of hot-pressed beryllium for a small range of beryllium oxide contents were measured from 300 to 1300°K for the first two properties and to 1100°K for the latter property. The thermal conductivity was measured by a guarded longitudinal heat flow method and electrical resistivity measurements were included on the same samples. The specific heat over the complete temperature range was determined by a combination of adiabatic and drop calorimetry techniques. The thermal conductivity at 300°K varied between 190 and 170 W $m^{-1}K^{-1}$ for the different purities and the corresponding electrical resistivities ranged between 4.1 and 4.7×10^{-8} Ω m. At higher temperatures, the differences in the two properties became somewhat smaller until, at 1300°K, common values to within ±3%, of 85 W m^{-1} and 46×10^{-8} Ω m, respectively, were obtained. The results are in good agreement with some previous work on similar materials which were carried out to 900°K only. The extension of the results to higher temperatures shows that the Lorenz function decreases slowly from 3.09 to 2.98 V^2K^{-2} between 300 and 1300°K and that the lattice component of conductivity is still a significant 16% contribution to the total thermal conductivity at the highest temperature. The specific heat of the material was found, within experimental accuracy, to be independent of the purity for the range of oxide contents studied. All experimental points were within ±2% of a mean line drawn through them and gave values of 1938 and 3150 J $kg^{-1}K^{-1}$ at 323 and 1123°K, respectively, which were some 0.5 to 2%, respectively, above published values for higher-purity beryllium. (auth)

39650 SEPARATION OF THE ELECTRONIC AND LATTICE CONTRIBUTIONS TO THE THERMAL CONDUCTIVITY OF METALS AND ALLOYS. Williams, R. K.; Fulkerson, W. (Oak Ridge National Lab., Tenn.). pp 389-456 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

Two independent methods were used for separating the electronic and lattice portions of the thermal conductivity of metals and dilute alloys. One method involved measuring the thermal conductivity and electric resistivity of a pure base metal and of one or more dilute alloys. For the simplest case of this method, the solutes were chosen so as to have as small an effect as possible on the lattice portion of the thermal conductivity and thus the lattice conductivity of the alloy was assumed to be the same or nearly the same as that of the pure metal. A more complicated case was also developed. In this case it was not necessary to assure that dilute alloys have the same lattice conductivity as that of the pure base metal, but only that this component of the thermal conductivity is reduced linearly with the concentration of the alloying constituent. This analysis was applied to rhenium alloys of tungsten and the results were compared with theory to show that the

mass difference formula for scattering of phonons by impurity atoms is inadequate and a lattice strain factor must be included. In the second method, the temperature dependence of the electronic and lattice portions of the thermal conductivity (for $T \geq \theta_D/3$) were assumed to be known from theory. The electronic portion was determined by using experimental electrical resistivity data with a theoretically based, temperature-dependent Lorenz function. The data for thermal conductivity and electrical resistivity were fitted by least-squares techniques to the function describing the total thermal conductivity, permitting the determination of appropriate constants that could not be obtained accurately from theory. Both methods gave very similar results for tungsten, iron, and molybdenum, for which accurate data on the pure metal and on some dilute alloys were available. The least-squares, curve-fitting technique was also applied to recent accurate data for Cu, Al, In, Cr, and Pt. For these latter metals there were no suitable alloy data available. For the VIB metals chromium, molybdenum, and tungsten and for platinum, the limiting high-temperature Lorenz function was significantly greater than the Sommerfeld value of 2.443×10^{-8} (v deg^{-1})^2, whereas for the relatively simple metals copper, aluminum, and indium and also for iron, the limiting value was equal to or slightly smaller than the Sommerfeld value. Platinum alone of the metals studied did not yield a constant high-temperature limit for the Lorenz function, although the value obtained at high temperatures was larger than the Sommerfeld value. The lattice portion of the thermal conductivity was found to be significant for W, Fe, Cr, and Pt and amounted to as much as 54% in iron at 120°K and 25% of the total for tungsten at 100°K. On the other hand, the lattice thermal conductivity of molybdenum seems anomalously small compared to that of the other VIB metals. (auth)

39651 MEASUREMENT OF THERMAL DIFFUSIVITY BY THE PHASE-SHIFT METHOD. Null, M. R.; Lozier, W. W. (Union Carbide Corp., Cleveland). pp 837-56 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

A phase shift method for the measurement of the thermal diffusivity of opaque materials at high temperature is described. A modulated beam of radiation from a carbon arc image furnace is used to heat the test material to temperatures between 1600 to 3000°K and to provide the reference signal for the phase shift measurements. Measurements are made of the sample thickness and of the modulation frequency to produce phase shifts of 180 or 360 degrees in the temperature signal transmitted through the sample. Corrections for the effects of sample thickness include: (1) a theoretically derived term, which depends almost linearly on the sample thickness, to allow for the effects of the axial heat flow loss factors at the surfaces and (2) an empirically derived term, which depends almost quadratically on the thickness, to allow for the effects of radial heat flow in the sample. Results are presented on the thermal diffusivity and thermal conductivity of materials which cover almost two orders of magnitude: pyrolytic graphite (c-direction), grade CEP graphite, and the metals tantalum and tungsten. The approximate values of the coefficient of variation are one to two percent for the metals and the grade CEP graphite and 4.5 percent for the pyrolytic graphite (c-direction). Errors resulting from the system itself are believed to be less than five percent. The values of thermal diffusivity and the derived values of thermal conductivity agree satisfactorily with data from other methods, including extensive work from the literature on tantalum and tungsten. (auth)

39652 THERMAL DIFFUSIVITY OF THE ELEMENTS. Ho, C. Y.; Powell, R. W.; Wu, K. Y. (Purdue Univ., West Lafayette, Ind.). pp 971-98 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

Experimental thermal diffusivity data are available for only 35 elements. Even for these 35, data are in many cases fragmentary and over a very limited temperature range, mostly around room temperature or above. Information on the thermal diffusivity below room temperature and for the molten state is particularly meager. For the rest of the elements, there are no experimental data available. In order to remedy this situation, this paper presents the derived thermal diffusivity of 75 elements over wide ranges of temperature—in many cases from near absolute zero to above the melting points of the elements. These thermal diffusivity values are provisional in nature and are derived from the TPRC recommended thermal conductivity, the specific heat selected from TPRC Series and other compilations, and the density from the literature or computed from thermal expansion data. The derived thermal diffusivity values are in agreement with the experimental data, when available. (auth)

39653 GERMANIDES. Samsonov, Grigorii V.; Bondarev, Vladimir N. New York; Primary Sources, Publishers (1970). 238p. $22.50.

Translation of Germanidy by Adolph Wald.

Experimental and theoretical data on the metallurgical constitution, electron structure, and physical properties of germanium and its compounds are presented. Descriptions of the preparation of germanium and its compounds, with elements of the periodic table, with emphasis on the germanide phases are provided. Stress is placed on the various applications of germanium and its compounds, e.g., semiconductors, precision metallurgy, protective coatings, heat resistors, and transducers. (R.C.K.)

39654 INTERPRETATION OF HYDROGEN SOLUTIONS IN bcc EARLY TRANSITION METALS. McQuillan, A. D. (Univ. of Birmingham, Eng.). J. Chem. Phys.; 53: 156-64(1 Jul 1970).

Marked departures from ideal thermodynamic behavior have been observed in dilute solutions of hydrogen in niobium and have been attributed to clustering of hydrogen atoms in the solutions. An attempt has been made to formulate a general physical picture of hydrogen solutions in the early transition metals and to show how this could give rise to the observed behavior in the niobium–hydrogen and other related hydrogen systems. Factors which are important in these systems are the very large number of interstices available to hydrogen in the body-centered cubic metal structure and the particular electronic structure of the early transition metals. A distinction has been drawn between dilute solutions in which dissolved hydrogen atoms may interact with each other by means of scattering of conduction electrons and more concentrated solutions in which the electronic structure of the metal is completely altered by the presence of a high concentration of hydrogen atoms in the metal. The transition from one type of behavior to the other would appear to occur in range 2 to 10 at.% hydrogen. Effects in dilute solutions and with the conditions governing the possible existence of pairs of associated hydrogen atoms in them are emphasized. A complete analysis of this problem in terms of many-body theory would appear, at the moment, to present considerable theoretical difficulty, and, therefore, a less rigorous model has been used. (auth)

39655 STEADY-STATE DIFFUSIONAL CREEP. Dupouy, Jean Michel (CEN, Saclay, France). Phil. Mag.; 22: 205-7 (Jul 1970).

Introduction of the effective stress for climb and a periodic internal stress field in Nabarro's model for diffusional creep modifies the original derivation in such a way that the creep rate varies with the applied stress as σ_E^m, where m can be very large. The role of climb is often underestimated in high temperature deformation, as is also suggested by creep experiments on beryllium and magnesium single crystals stressed in compression along the c axis. (auth) (UK)

Structure and Phase Studies

Refer also to abstract 39718.

39656 (RT/MET–(69)2) TRANSFORMATION PROCESS IN SEVERAL ALLOYS OF URANIUM WITH LOW MOLYBDENUM AND NIOBIUM CONTENT. Castaldelli, L.; Fizzotti, C.; Gandini, A. G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 28 Mar 1969. 42p. (In Italian). Dep. CFSTI (U. S. Sales Only).

TTT curves of the following uranium alloys containing 1% molybdenum, 1% niobium, 0.5% molybdenum + 0.5% niobium, and 0.2% molybdenum + 0.7% niobium are shown and discussed. Transformations occurring at particular temperatures are discussed together with the morphology of the precipitated phases. (auth)

39657 NEUTRON-DIFFRACTION STUDIES OF $TmAu_2$, $YbAu_2$, AND $TmAg_2$ AT 300 TO 1.7°K. Atoji, Masao (Argonne National Lab., Ill.). J. Chem. Phys.; 52: 6433-4(15 Jun 1970).

Diffraction data were taken using 1.069-Å neutrons, and the unit cells (Å) at 300°K were determined to be: ($TmAu_2$) a = 5.153, c = 8.896; ($YbAu_2$) a = 5.1378, c = 8.8826; and ($TmAg_2$) a = 5.1647, c = 9.140. No coherent magnetic peaks were found for $TmAg_2$ and $YbAu_2$ down to 1.7°K, but $TmAu_2$ shows the onset of antiferromagnetism at 3.2°K. The ordered moment at 1.7°K is about 40% of the free-ion moment of 7.00 μ_B. (D.L.C.)

39658 COMPUTER CALCULATION OF PHASE DIAGRAMS. WITH SPECIAL REFERENCE TO REFRACTORY METALS. Kaufman, Larry; Bernstein, Harold. Refractory Materials. A Series of Monographs. Volume 4. New York; Academic Press Inc. (1970). 344p. $15.00.

A formalism for computing phase equilibria and stability in metallic systems is presented. Chapters are included on lattice

stability, binary systems, refractory metal systems, compound phases, phase stability, and ternary phases. (J.R.D.)

39659 C CURVES OF THE DECOMPOSITION OF SUPERSATURATED SOLID SOLUTIONS IN Al–Zn–Mg ALLOYS WITH ADDITIONS OF Mn, Cr, Zr, AND Cu. Zakharov, V. V.; Novikov, I. I.; Elagin, V. I.; Levin, L. I. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 110-16(1970). (In Russian).

Alloying of the Al–Zn–Mg alloy by Mn, Zr, and especially by Cr leads to a strong reduction in the stability of the supersaturated solid solutions of Zn and Mg in Al. With an increase in the content of Mn up to 0.93%, Cr to 0.24%, and Zr to 0.23%, the stability of the solid solution continuously decreased. Successive metals decreased the stability of the solid solution as a result of initiating secondary dispersion of intermetallics, which were previously isolated from the solid solution and also as a result of its increased supersaturation by Zn and Mg. (tr-auth)

39660 PRECIPITATION PROCESSES IN PURE VANADIUM AND VANADIUM–TITANIUM ALLOYS. Kramer, K.-H. (Kernforschungszentrum, Karlsruhe, Ger.). J. Less-Common Metals; 21: 365-82(1970). (In German).

Electronmicroscopic investigations of the precipitation phenomena in pure vanadium and vanadium–titanium alloys showed that these precipitates consisted of a cubic phase of NaCl structure of the B I lattice type. In pure vanadium, vanadium oxide VO was formed with a lattice constant of 4.12 ± 0.06 Å, and in vanadium–titanium alloys titanium oxide TiO with a lattice constant of 4.19 ± 0.06 Å. The following relation exists in terms of orientation between the plate-shaped particles precipitated and the matrix: $(001)_M \parallel (001)_A$ M = matrix, and $[100]_M \parallel [110]_A$ A = precipitate. On the (001) habit planes the precipitated particles were coherent with the matrix, while there was no coherence perpendicular to these planes. In vanadium–titanium alloys, the number of TiO particles precipitated increased with increasing oxygen content. The particle size in this case did not change, only the distance between particles was diminished. With increasing titanium content, the number and volume fraction of the precipitated particles decrease. An estimate of the solubility of oxygen in vanadium–titanium alloys indicated that oxygen in the dissolved form was present in addition to the precipitate of TiO. In the course of an annealing treatment the dissolved oxygen was precipitated as TiO, resulting in an increase in thickness of the precipitated particles. With increasing titanium content the solubility of oxygen in vanadium–titanium alloys increased. (auth)

39661 YTTERBIUM–SILVER SYSTEM. Palenzona, A. (Univ., Genoa). J. Less-Common Metals; 21: 443-6(1970).

The phase diagram for the ytterbium-silver system was determined and structural data was reported for the phases whose structure was resolved. The valence of ytterbium was discussed. (G.M.C.)

39662 POLYMORPHISM OF THE COMPOUND TbNi. Lemaire, R.; Paccard, D. (CNRS, Grenoble, France). J. Less-Common Metals; 21: 403-13(1970). (In French).

The crystalline structures of the compound TbNi were of two types depending upon the heat treatment. The first type, TbNi obtained when the liquid was quenched, crystallized in space group Pnma with a = 21.09 Å, b = 4.22 Å, and c = 5.45 Å. The second type, TbNi, obtained when the compound was annealed at 950°C, crystallized in space group $P2_1/m$ with a = 21.26 Å, b = 4.21 Å, c = 5.45 Å, and $\beta = 97°25'$. As for the FeB and CrB type structures, these two new type structures contained a common structural unit, the trigonal prism, which was stacked differently to form either structure. On this basis, a set of transformation equations relating the lattice constants of both structure types is derived. (auth)

39663 YTTRIUM–ANTIMONY ALLOY SYSTEM. Schmidt, F. A.; McMasters, O. D. (Ames Lab., Iowa). J. Less-Common Metals; 21: 415-25(1970).

A phase diagram is proposed for the yttrium–antimony system based on thermal, microscopic, chemical, and x-ray analyses. An inverted peritectic reaction developed as a result of antimony additions, lowering the 1475°C transformation temperature of yttrium to 1462°C. Eutectic reactions occurred at 14.5 at. % antimony and 1220°C, and greater than 99.0 at. % antimony and 629°C. There are four compounds in the system. The compound YSb melted congruently at 2310°C while Y_3Sb and Y_5Sb_3 resulted from peritectic reactions at 1240° and 1690°C. The fourth compound, Y_4Sb_3, formed peritectically at 2120°C, but decomposed by a eutectoid reaction at 1660°C. (auth)

39664 EFFECT OF PRESSURE AND TEMPERATURE ON THE LATTICE PARAMETERS OF RHENIUM. Liu, Lin-gun; Takahashi, Taro; Bassett, William A. (Univ. of Rochester, N. Y.). J. Phys. Chem. Solids; 31: 1345-51(Jun 1970).

The effect of pressure on the lattice parameters, hence the molar volume, of the hexagonal close-packed phase of rhenium (Re) was determined at room temperature up to 350 kbar by means of x-ray diffraction employing a diamond-anvil high-pressure cell. The initial bulk modulus of rhenium calculated from the volume data is 3.50 ± 0.15 Mbar. The crystallographic axis ratio, c/a, is virtually independent of pressure. No phase transformation was observed within the pressure range studied. The mean coefficients of linear thermal expansion were determined to be $(7.03 \pm 0.10) \times 10^{-6}°C^{-1}$ for the a-axis and $(4.96 \pm 0.07) \times 10^{-6}°C^{-1}$ for the c-axis in a temperature range of 12–428°C at a pressure of 1 bar by means of the x-ray diffraction method. (auth) (UK)

Radiation Effects

Refer also to abstracts 39726, 40892, 40897, 40898, 40900, and 41040.

39665 (AERE-R-5546) RANGE CALCULATIONS OF 10 TO 200-keV HEAVY IONS IN MATERIALS. Matthews, M. D.; Holloway, D. F. (Atomic Energy Research Establishment, Harwell (England)). Sep 1967. 27p. Dep. CFSTI (U. S. Sales Only).

Stopping processes and range concepts of 10 to 200 keV heavy ions injected into solids are discussed. The elements of theoretical treatments presented by Nielsen and Lindhard et al. to calculate range values are described and their results used to derive range values for various ions in a number of target materials (Si, Ge, Au, Cu, Ag, U, graphite and Ir) of interest to groups working on radiation damage and ion implantation problems. Particular reference is made to ranges in the semiconductors Si and Ge. (auth)

39666 (AI-AEC-12960) THE EFFECTS OF HELIUM ON HIGH-TEMPERATURE DUCTILITY OF SANDVIK 12R72HV AND INCO IN-744X. Kramer, D.; Garr, K. R.; Rhodes, C. G.; Pard, A. G. (Atomics International, Canoga Park, Calif.). 24 Jun 1970. Contract AT(04-3)-824. 19p. Dep. CFSTI.

Small tensile samples of Sandvik 12R72HV and Inco IN-744X were injected with helium by means of α-particle irradiation from a cyclotron to produce approximately uniform concentrations of from 1×10^{-6} to 2.5×10^{-5} atom fraction. The samples were subsequently tensile tested in vacuum between 500 and 800°C. Sandvik 12R72HV is significantly more resistant to helium embrittlement than Types 304 or 316 stainless steel. Helium in Inco IN-744X has little effect on the superplastic behavior of this alloy. (auth)

39667 (CEA-CONF-1527) EFFECTS OF FAST NEUTRON IRRADIATION ON DIFFUSION PHENOMENA IN THE SYSTEM ALUMINUM–MAGNESIUM. Moreau, Guy (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1969. 3p. (In French). (CONF-690957-1). Dep. CFSTI (U. S. Sales Only).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England.

The chemical diffusion by means of thick diffusion couples in the aluminum–magnesium system is studied under normal thermal conditions and under fast neutron irradiation (>1 MeV) in a specially designed device implanted in a swimming pool reactor. The mean radiation doses are found to be $10^{18}n/cm^2$. The growth of diffusion zones, the evolution of solubility, and the chemical diffusion process are examined. (auth) (France)

39668 (WANL-TME-1656) FRACTURE TOUGHNESS OF NEUTRON IRRADIATED BERYLLIUM. Harrod, D. L.; Manjoine, M. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Sep 1967. Subcontract NP-1. 16p. Dep. CFSTI.

The post-irradiation fracture toughness, K_{IC}, of neutron irradiated S-200 grade beryllium was determined using wedge-opening-loading test specimens. Irradiation at 77°K to an integrated neutron flux of 5×10^{17} nvt (E > 1 MeV) decreased the fracture toughness by about 40% for test temperatures below about 190°K. The irradiation damage was recoverable, as it annealed out upon warming to room temperature. The effect of the irradiation on fracture toughness is interpreted in terms of its effect on the ability of beryllium to exhibit localized plastic deformation at the tip of a crack, as opposed to its effect on the true surface energy of the newly created crack surface. (auth)

39669 RADIATION HARDENING IN NIOBIUM: DEPENDENCE OF THE YIELD STRESS ON NEUTRON DOSE. Tucker, R. P.; Wechsler, M. S. (Oak Ridge National Lab., Tenn.). Radiat. Eff.; 3: 73-87(May 1970).

Niobium samples were neutron-irradiated at reactor ambient

temperatures (approximately 50°C for polycrystals and 90°C for single crystals) to doses from 4×10^{15} to 8×10^{18} neutrons/cm^2 (E > 1 MeV). The density and size distribution of radioinduced defect clusters, observed by transmission electron microscopy (TEM), were measured in polycrystalline niobium over a range of doses from 2×10^{17} to 4.4×10^{18} neutrons/cm^2. The TEM results were correlated with yield stress measurements as a function of dose. The radiation hardening was analyzed on the basis of a planar dispersed barrier model. It was found that the observed increases in yield stress at low doses were consistent with the measured density and size distribution of the defect clusters, with a cluster strength of 0.5 to 0.8 Gb^2 (G, shear modulus; b, Burgers vector). This corresponds to strong barrier hardening. At doses above about 10^{18} neutrons/cm^2, the hardening rate decreased sharply; this apparent saturation is discussed in terms of the coarsening of defect clusters, dislocation channeling, and the effect of interstitial impurities. (auth)

39670 ROENTGENOGRAPHIC INVESTIGATION OF RADIATION AND QUENCHED DEFECTS IN COPPER. Malinenko, I. A.; Shivrin, O. N. (Petrozavodsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 7-13(1969). (In Russian).

Roentgenographic methods were used to study defects in copper following gamma irradiation and quench hardening from high temperatures. Polycrystalline homogeneous Cu of 99% purity was cut from bars and studied. Copper powder of 5μ particle size, obtained by means of pressing at 140 kg/m^2 was also studied. The powder was annealed at 600°C for 1 hour and exposed to pulsed gamma radiation at 1.3 MeV at doses of 10^3, 10^4, 10^5, and 10^6 R. Irradiation was followed by quench hardening in water from 600°C. The homogeneous bar specimens were quench hardened in water from 600, 800, and 1000°C. (tr-auth)

39671 LOW-TEMPERATURE THERMAL CONDUCTIVITY OF COPPER IRRADIATED WITH REACTOR NEUTRONS. Bowman, H. F.; Ziebold, T. O.; Smith, J. L. Jr. (Massachusetts Inst. of Tech., Cambridge). pp 175-84 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

High purity copper was irradiated at 54°C in the M.I.T. Reactor to several exposures up to 6.5×10^{19} neutrons/cm^2. The thermal conductivities of the irradiated test samples and unirradiated controls were measured as a function of temperature between 4.5 and 100°K. Significant reductions, up to a factor of 25, were observed in the low-temperature thermal conductivity as a result of lattice defects induced by neutron bombardment. These samples were subsequently used in a study of pool-boiling heat transfer to liquid helium. (auth)

39672 HOT-CELL DETERMINATION OF THE THERMAL CONDUCTIVITY OF IRRADIATED REACTOR FUELS. di Novi, R. A. (Argonne National Lab., Ill.). pp 805-14 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

An investigation of the effect of irradiation on the thermal properties of reactor fuels has been initiated as part of the fuel-performance evaluation program at Argonne National Laboratory. Since the levels of irradiation necessitated that the experimental work be conducted in a hot cell with the use of slave manipulators, the elegantly simple USNRDL pulse technique was chosen to measure the thermal diffusivity and to determine the thermal conductivity of the irradiated fuels. This paper describes both the room-temperature and the high-temperature (measurements to 600°C) facilities that have been installed in a hot cell; also discussed are the experimental techniques that were developed to obtain measurements in a remote environment and the precautions taken to ensure trouble-free operation of the facilities on a long-term basis. Room temperature measurements were made on transverse and longitudinal sections of uranium-5 wt % fissium alloy, which was irradiated as unconstrained pins to average burnups of 0.32, 1.8, and 3.0 at. %. These results indicate the following: postirradiation diffusivity and conductivity are anisotropic; with irradiation, loss in conductivity is greater than that in diffusivity; and loss of conductivity and diffusivity is a function of the fuel swelling. These results will be presented in detail and interpreted on the basis of the increase in porosity due to fission-gas bubble nucleation. (auth)

39673 GROWTH AND STABILITY OF VOIDS IN IRRADIATED METALS. Bullough, R.; Eyre, B. L.; Perrin, R. C. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Appl. Technol.; 9: 346-55(Sep 1970).

A model has been developed to describe the kinetics of void growth in metals during irradiation which explicitly includes the presence of both migrating interstitials and vacancies. It is clear that void growth can only occur when an excess flux of vacancies arrives at the void surface and this can be achieved by taking into account the preferred drift of the interstitials to the dislocation sinks as a result of the long range size effect interaction. Results of numerical calculations of the vacancy and interstitial average concentration in stainless steel and molybdenum irradiated under typical fast reactor conditions are presented, and these are used to calculate void growth rates as a function of temperature. It is shown that the void growth rate goes through a maximum when plotted against temperature and this is consistent with the experimental swelling data. During the early stages of irradiation when the number of point defects arriving at voids is negligible compared with those being lost at other sinks, the swelling rate is proportional to $(t)^3$ (t = time). Cold work has a beneficial effect in the early stages of irradiation by reducing the void growth rates, but it could have a deleterious effect over a long term by prolonging the period over which the swelling follows the rapid $(t)^3$ law. (auth)

39674 COMMENTS ON DISLOCATION STRUCTURES IN IRRADIATED AND STRAINED IRON. Smidt, F. A. Jr. (Naval Research Lab., Washington, D. C.). Scr. Met.; 4: 517-20(Jul 1970).

The effects of dislocation channeling on the strain hardening coefficient of Fe and on the development of cell structure at high strains are analyzed. It is shown that the process of dislocation channeling in irradiated metals leads to a restriction in cross-slip of screw dislocations with attendant decrease in strain hardening coefficients. It is also shown that channeling occurs in irradiated Fe in the same manner as in other metals and that restricted cross-slip in irradiated metals leads to larger cell sizes with narrower, higher dislocation density cell walls. (J.R.D.)

39675 REPLY TO: COMMENTS ON DISLOCATION STRUCTURES IN IRRADIATED AND STRAINED IRON. Bryner, J. S. (Brookhaven National Lab., Upton, N. Y.). Scr. Met.; 4: 521-4 (Jul 1970).

It is noted that in specimens of irradiated Fe the dislocations were not segregated in highly localized areas, but were distributed fairly uniformly. The data obtained from highly strained specimens are considered as evidence against dislocation channeling in Fe. (J.R.D.)

39676 RADIATION DAMAGE AND STAGE III ANNEALING OF MOLYBDENUM. Afman, H. B.; Mooy, J. H.; Rademaker, H. (Univ., Amsterdam). Scr. Met.; 4: 545-8(Jul 1970).

Experimental results are presented with accompanying analysis to show that the migration of vacancies is responsible for the stage III annealing of irradiated Mo. (J.R.D.)

Ceramics and Cermets

Refer also to abstracts 39598, 39600, 39601, 39636, and 39637.

39677 MATERIALS IN SPACE TECHNOLOGY. I. Proceedings of the Symposium Held at Bristol, England, 10-11 April 1969. Groves, G. V. (ed.). J. Brit. Interplanet. Soc.; 22: 309-84(Oct 1969). (CONF-690442).

Papers presented at the conference are concerned with materials for space application, Be technology, C reinforced plastic composites, C composites for rocket motors; properties of silicon nitride, and materials for microelectronic circuits. The paper on Be technology was previously abstracted in NSA and appeared as 24: 14724. (J.R.D.)

Corrosion and Erosion

Refer also to abstract 38807.

39678 (DP-Report-112) EFFECT OF IN-PORE DIFFUSION ON GRAPHITE CORROSION RATE. Project DRAGON. Wicke, E. (Muenster Univ. (West Germany). Institut fuer Physikalische Chemie). Aug 1962. 25p. (CONF-620305-3). Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, England.

A theoretical appraisal was made of the effect of diffusion into pores of graphite on the rate at which the graphite would corrode. The particular problem is the rate at which graphite would corrode when a gas containing an oxidant such as oxygen, carbon dioxide, or water vapor flowed past it, as, for example, an impure helium coolant of the Dragon reactor flowing through the graphite core. (auth)

39679 (DP-Report-391) CORROSION RATE OF GRAPHITES BY CO_2 AND H_2O-VAPOR TAKING INTO ACCOUNT IN-PORE DIF-

FUSION AND TEMPERATURE GRADIENTS. Project DRAGON. Final Report. Wicke, E.; Hedden, K.; Hugo, P.; Loewe, A. (Muenster Univ. (West Germany). Institut fuer Physikalische Chemie). Jan 1966. 66p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, England.

The reactivity of a series of samples of crushed graphite was determined as a function of burn-off with carbon dioxide at temperatures of 1000 to 1200°C. The results are given in plots of the first order rate constant k_m against the percentage carbon consumed. Rates of reaction of graphite with low partial pressures of carbon dioxide and water vapor in helium as carrier gas were investigated. The influence of in-pore diffusion on the corrosion rate of graphite with linear temperature gradients was studied. (auth)

39680 (NP-9982) BIBLIOGRAPHIC STUDY OF OXIDATION OF CARBON. Project DRAGON. Pointud, M. L. (Atomic Energy Establishment, Winfrith (England)). Feb 1961. 15p. (DP-Report-16). Dep. CFSTI.

A study of various investigations that have been made into the oxidation of carbon by oxygen, carbon dioxide and steam are described. The study is limited to the works which give the most information for the corrosion experiments to be carried out on the graphite which will be used in Dragon. A table summarizing the findings of the different authors is included. It is concluded that the various authors do not agree on the different factors which play a part in the corrosion of carbon. This may be due to the variety in structure, porosity and purity of the samples of graphite used. (auth)

39681 (RD/B/N-1588) REVIEW OF THE GASEOUS OXIDATION OF PYROCARBON AND OF THE BOUDOUARD REACTION. Collins, A. C.; Dominey, D. A.; Swan, T. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). May 1970. 24p. Dep. CFSTI (U. S. Sales Only).

Literature on the thermal oxidation of the pyrocarbon coatings of fuel particles and the associated compacting material by carbon dioxide and water vapour is reviewed together with data on the thermal deposition of carbon from carbon monoxide. The extrapolation of these data to high temperatures and to both high and low gas pressures is discussed. The rates of radiolytic oxidation and carbon deposition are estimated and compared with the rates of the corresponding thermal reactions. (auth) (UK)

39682 CORROSION OF ZrO_2 BY Ir ON HEATING. Gorski, W. (Max-Planck-Institut fuer Silikatforschung, Wuerzburg, Ger.). Z. Anorg. Allg. Chem.; 358: 163-9(May 1968). (In German).

On heating in an oxidizing atmosphere stabilized zirconia and metallic iridium a severe corrosion, beginning at about 1500°C, occurs. No chemical change, however, of the reacting components is observed after cooling. Alumina similarly reacts with iridium. Intermediary existing compounds of oxide and iridium oxide are therefore supposed, which dissociate immediately. For this reason iridium is not suitable as a high temperature container material for oxides in an oxidizing atmosphere. (auth)

Preparation and Fabrication

Refer also to abstracts 39171, 39181, 39202, 39611, 39616, 40875, 40882, 40884, 40886, 40890, 40891, 40991, 40999, and 41005.

39683 (BAW-3714-17) GEL-ADDITION PROCESS CHEMICAL STUDIES. Quarterly Progress Report No. 15, February-April 1970. Carlson, R. V. (comp.) (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Jun 1970. Contract AT(30-1)-3714. 38p. Dep. CFSTI.

The development of a sol-gel process and related processes for preparing $(U,Pu)O_2$ fast reactor fuels has continued. Progress for the 15th quarter, ending April 30, 1970, is reported. Sufficient $(U,Pu)O_2$ fuel was prepared for the initial bundle to be irradiated in the EBR-II. About 450g of coarse $^{235}UO_2$– 20% PuO_2 microspheres was formed in the unit-operation-scale spheroidizing system, and about 350g of fines was formed in laboratory-scale equipment. Since the first lot of coprecipitated $^{235}UO_2$– 20% PuO_2 powder was found to have a high aluminum content, a new lot containing about 2.2 kg of powder was prepared. Sufficient fuel pellets and shards for the initial EBR-II irradiation test were fabricated from the second lot of powder. A capsule in the "time-for-restructuring" series was placed in the BAWTR for an 81-day irradiation at 6 kW/ft. It was removed after 55 days when abnormal operating temperatures were indicated. Post-irradiation examination of 10 BAWTR capsules was begun. A screening gamma scan indicated that there are no fuel pin ruptures or other failures that would produce an abnormal axial fission product distribution. (auth)

39684 (DP-Report-69) THE PRESENT STATUS OF THE SYSTEM URANIUM–THORIUM–CARBON. Project DRAGON. Houyvet, A. (Atomic Energy Establishment, Winfrith (England)). Nov 1961. 26p. Dep. CFSTI.

The uranium carbon system is more and more extensively studied, but until now the technological side was explored more than the fundamental side and many determinations of properties were only worth while for a particular case of preparation and utilization. The other binary systems and the ternary system are only beginning to be explored and the problem of preparing well defined reproducible compounds is not completely solved. Some irradiation tests were performed on uranium monocarbide, but for this, as for other properties, the results obtained are strictly limited to the particular samples used in each case. A generalization is not yet possible. (auth)

39685 (DP-Report-161) THE PREPARATION OF GRAPHITE WITH A NARROW SPECTRUM OF FINE PORES. Project DRAGON. Bentolila, J. (Compagnie Pechiney, Paris (France)). Jul 1965. 48p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

Conditions were defined for the preparation of graphite having an open porosity of about 15% composed entirely of pores whose diameter was within the range 0.1 to 1μ. This condition was imposed in order to facilitate subsequent impregnation with furfuryl alcohol. After having studied the pore spectra of graphites of very diverse grades and then, more particularly, of high density graphites, it was concluded that the pore spectrum was determined principally by the granulometric composition of the carbon powders used. The judicious choice of the particle size of such powders resulted in three satisfactory formulae. The influence of the many variables of the process on the most important characteristics of the finished product (pore spectrum and permeability) were defined; in particular, the amount of binder only slightly modified these two properties but played a basic part in obtaining sound products. Translation of these results to full scale manufacture has brought difficulties in baking, which are not yet resolved. (auth)

39686 (DP-Report-266) TEMPERATURE DISTRIBUTIONS IN LABORATORY SCALE COATING FURNACES. Project DRAGON. Kern, D.; Gough, J. R. C. (Atomic Energy Establishment, Winfrith (England)). Apr 1964. 27p. Dep. CFSTI.

Temperature distributions in laboratory scale (up to 50 g charge) fluidized bed coating furnaces have been investigated as a function of gas flow, weight of charge, and density of fuel particles. The use of a platinum/platinum 13% rhodium thermocouple limited the range investigated to a maximum of 1450 to 1500°C. Measurements of temperature in a fluidized bed of fuel particles give a good indication of the bed height and location with respect to the gas inlet nozzle. Increase in the weight of charge has been shown to improve uniformity of temperature distribution and increase the average bed temperature. The temperature gradient in the bed of fuel particles increases with their density. An improved nozzle design has been shown to give very uniform distribution of temperature as compared with the previous design. (auth)

39687 (DP-Report-273) SINTERABILITY OF THORIUM–URANIUM–DICARBIDE FUEL KERNELS. Project DRAGON. Bisdorff, L. (Atomic Energy Establishment, Winfrith (England)). Apr 1964. 28p. Dep. CFSTI.

The dry pressureless sintering behavior of $(Th,U)C_2$-kernels N = 14 : 1 was investigated at various temperatures. It has been found that at temperatures lower than 2200°C no significant sintering of these kernels takes place. (auth)

39688 (DP-Report-274) WORK ON THE DRAGON FUEL AT R.A.E. FARNBOROUGH SINCE JANUARY 1963. Project DRAGON. Bickerdike, R. L.; Ranson, H. C.; Hughes, G. (Atomic Energy Establishment, Winfrith (England)). Apr 1964. 28p. Dep. CFSTI.

Results of investigations on the parameters of coating deposition on fuel kernels are presented. The parameters investigated include deposition rate effects on density, preferred orientation of deposited carbon, effects of heat treatment, radioinduced fission product release, and effects of pressure on fuel particle at deposition. (J.R.D.)

39689 (DP-Report-297) RESEARCH INTO THE SOL-GEL PROCESS OF PREPARING CARBIDE FUEL PARTICLES. Semi-Annual Report, January 1–July 1, 1964. Project DRAGON. Hermans, M. E.; v. d. Plas, Th. (Atomic Energy Establishment, Winfrith (England)). Oct 1964. 12p. Dep. CFSTI.

It is shown that particles with diameters of 250 to 1,000 microns, consisting of an intimate mixture of thoria, uranis, and carbon can be prepared by a modification of the existing

KEMA process. The particles are spherical with an almost smooth surface and have neither visible surface cracks nor holes in the interior. The process is simple and could be scaled up without major difficulties. (auth)

39690 (EURAEC-2115) USE OF PLUTONIUM AS FUEL IN NUCLEAR REACTORS. Final Report, January 1, 1964-December 31, 1968. (Societe Belge pour l'Industrie Nucleaire, Brussels). Jun 1969. 61p. Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Development of methods for fabrication of UO_2-PuO_2 fuels with PuO_2 only in the fine fraction is reported. Improvement by optimizing the particle size ratios and by upgrading vibration and filling techniques is reported. (J.R.D.)

39691 PREPARATION AND CHARACTERIZATION OF BORON FILMS FROM DIBORANE. Croft, W. J. (Army Materials and Mechanics Research Center, Watertown, Mass.); Tombs, N. C.; Fitzgerald, J. F. Mater. Res. Bull.; 5: 489-94(Jul 1970).

The thermal decomposition of diborane, B_2H_6 has been used as the basis for a method of forming adherent coatings of boron on various substrates. The purity and other properties of the films were studied by emission spectrograph, electron microscope and optical techniques. The method of preparation described appears to have advantages compared with established methods. (auth)

39692 INVESTIGATIONS ON HYDROLYZABLE CARBIDES. I. PRODUCTION AND DECOMPOSITION OF LANTHANUM DICARBIDE. Hajek, B.; Brozek, V.; Popl, M. (Technische Hochschule fuer Chemie, Prague). Collect. Czech. Chem. Commun.; 35: 1832-43(Jun 1970). (In German).

Optimal conditions for the preparation of lanthanum dicarbide by reduction of lanthanum oxide with excess carbon are described The compound was prepared and its decomposition in water and dilute sulfuric acid solutions at room temperature was investigated. The hydrolytic behavior was studied in relation to time and particle size. The composition of the gaseous products was determined by uv and ir spectroscopy as well as gas chromatography. It was established that, on hydrolysis of lanthanum dicarbide in an excess of liquid, a mixture of hydrogen and acetylene, as well as hydrocarbons of the C_2 and C_4 series, was formed. (tr-auth)

39693 METHOD OF OBTAINING THIN LAYERS BY ELECTROLYTIC DEPOSITION, AND THE PRODUCT OBTAINED BY SUCH METHOD. Lefevre, Antoinette; Lefevre, Jean (to Commissariat a l'Energie Atomique). British Patent 1,192,117. 20 May 1970. Priority date 29 Nov 1967, France.

A method for cathodic deposition of thin adherent layers of inorganic compounds such as $SrTiO_3$ or rare earth hydroxides on solid substrates from alcohol-base electrolytes is described. (auth)

39694 METHOD FOR THE PRODUCTION OF NUCLEAR FUEL. (to Progettazioni Meccaniche Nuclear SpA). British Patent 1,199,130. 15 Jul 1970. Priority date 11 Jul 1968, Italy.

A method is described for preparation of coated fuel particles. A minor percentage of the particles contain nonfissile materials and are magnetic. These can be magnetically separated from the fissile particles for use in quality control testing of the coating. (J.R.D.)

39695 PYROLYTIC GRAPHITE AND NUCLEAR FUEL PARTICLES COATED THEREWITH AND PROCESS FOR MAKING SAME. (to Gulf General Atomic Inc.). British Patent 1,196,630. 1 Jul 1970. Priority date 7 Apr 1967, United States.

A method of preparing particulate fuels coated with pyrolytic graphite with improved stability, is described. The coated fuels retain fission products well at high temperatures. The coatings can be applied at reasonable temperatures and annealed to graphite at 2000 to 2400°C using a refractory metal catalyst. (J.R.D.)

39696 PRODUCTS MANUFACTURED FROM THE COMPOSITE MATERIAL Al-Mg-Al_2O_3-MgO FOR NUCLEAR APPLICATIONS, AND METHODS OF OBTAINING THE PRODUCTS AND THE MATERIAL. Gualandi, Dante; Jehenson, Pierre (to European Atomic Energy Community). British Patent 1,200,969. 5 Aug 1970. Priority date 31 Aug 1967, Italy.

A process for production of composite materials from Al-Mg-Al_2O_3-MgO is described. Powdered Al-Mg alloy is further ground in the presence of oxygen for partial oxidation to Al_2O_3 and MgO. The cermet is then degassed and vacuum sintered to form a double oxide dispersed in the product metal. The sintered composite material can be formed into tubes for fuel cans. (J.R.D.)

39697 ELECTRODEPOSITION OF ZIRCONIUM DIBORIDE FROM OXIDES DISSOLVED IN FUSED SALTS. Anthony, K. E.; Welch, B. J. (New South Wales Univ., Kensington, Australia). Aust. J. Chem.; 22: 1593-7(Aug 1969).

Zirconium diboride has been cathodically electrodeposited from ZrO_2 and B_2O_3 dissolved in an equimolar mixture of K_2ZrF_6 + KBF_4 at 600°. The deposition process is controlled by the concentration of B_2O_3 in the molten salt solution, and at higher current densities zirconium is co-deposited. Carbon dioxide is evolved simultaneously from a graphite anode. (auth) (Australia)

Properties Evaluations

Refer also to abstracts 38805, 39105, 39108, 39614, 39624, 39626, 39651, 39652, 40875, 40882, 40884, 40890, 40891, and 41000.

39698 (DP-Report-98) MEASUREMENT OF SPECTRAL EMISSIVITY OF EYX 60 GRAPHITE. PART II. EMISSIVITY REPORT. Project DRAGON. Stillwell, J. C. (Atomic Energy Establishment, Winfrith (England)). Jun 1962. 18p. Dep. CFSTI.

A method of measuring emissivities of electrically conducting refractory materials independent of other physical properties which may be unknown is described. The techniques of measurement of spectral emissivities are now well tried and reproducible results were obtained, using graphite, with an accuracy of ±7%. The apparatus is additionally suitable for measuring the thermal conductivity of graphite in the radial direction. A rig capable of higher power rating than the present is in course of construction and this will permit the use of thick specimens for thermal conductivity measurement. (auth)

39699 (DP-Report-164) STUDY OF THE INFLUENCE OF PARTICLE SIZE DISTRIBUTION ON THE PORE SPECTRUM OF FINE GRAIN GRAPHITES. Progress Report No. 207, July 1962. Project DRAGON. Bentolila, J.; Chedde, Pechiney (Compagnie Pechiney, Paris (France)). May 1963. 28p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

The object of this study was to formulate more precisely the relations existing between the particle size distribution of the raw materials and the pore spectrum of the resulting graphitized products. Two series of experiments were carried out: the particle size of the finest fraction (i.e., the carbon black) was varied; and graphitized products were prepared from each of the separate raw material components. Finally the methods were clarified by which fine grain graphites with a given pore spectrum can be prepared using graphite powders as starting materials. (auth)

39700 (DP-Report-208) THE CHOICE OF GAS BEARING MATERIALS. Project DRAGON. Fricker, H. W. (Atomic Energy Establishment, Winfrith (England)). Aug 1963. 31p. Dep. CFSTI.

Investigations of gas bearing materials revealed that promising materials include PTFE compounds and carbons or graphites. The latter have the advantage of the higher temperature resistance and are little affected by irradiation. A combination like tungsten carbide-CY 132, properly cooled, could be used as a dry bearing instead of most present day gas bearings, if some wear can be tolerated. Alternatively, if such a combination were used in a gas bearing it would stand an unusual amount of overloading or underspeeding, and its reliability would be similar to a good oil lubricated bearing. (J.R.D.)

39701 (DP-Report-358) DIFFUSION OF BARIUM, STRONTIUM AND CERIUM IN VARIOUS GRADES OF REACTOR GRAPHITE. Project DRAGON. Faircloth, R. L.; Pummery, F. C. W.; Rolls, B. A. (Atomic Energy Research Establishment, Harwell (England)). Jul 1965. 27p. (AERE-R-4994). Dep. CFSTI.

The diffusion of barium and strontium in CYX 165 and HX 30 graphites, and of barium in G5 graphite and pyrographite was studied using an electron microprobe. A sectioning technique was applied to the diffusion of cerium in HX 30 graphite. It was concluded that the movement of these metals through well-formed polycrystalline graphite and pyrographite occurs by activated surface diffusion, combined possibly with vapor-phase migration, through microstructural defects. In graphite containing ungraphitized material the bulk of the mass transfer occurs along the surface of this component. (auth)

39702 (GEAP-12066) THERMODYNAMIC DATA PROGRAM INVOLVING PLUTONIA AND URANIA AT HIGH TEMPERATURES. Quarterly Report No. 10, December 1969-February 1970. Aitken, E. A.; Evans, S. K. (General Electric Co., Pleasanton, Calif. Nucleonics Lab.). Apr 1970. Contract AT(04-3)-189. 4p. Dep. CFSTI.

Results of work related to vaporization of urania, oxygen redistribution in a temperature gradient, and sodium fuel interactions

are presented. The scope of new experiments to extend the study of oxygen activity in UO_2-PuO_2 systems to higher temperatures is described. (auth)

39703 SOLUBILITY OF BORON IN ALPHA SILICON CARBIDE. Shaffer, Peter T. B. (Carborundum Co., Niagara Falls, N. Y.). Mater. Res. Bull.; 5: 519-22(Jul 1970).

The solubility limit of boron in alpha silicon carbide is 0.2 weight percent or less at 2450 to 2500°C. This limit was determined by lattice dimension changes and confirmed petrographically. (auth)

39704 REACTIONS OF ANODICALLY PRODUCED NIOBIUM OXIDE LAYERS. Heusler, K. E.; Schlueter, P. (Max-Planck Institut fuer Metallforschung, Stuttgart). Z. Phys. Chem. (Frankfurt); 69: 140-52(May 1970). (In German).

It is shown that anodic niobium oxide films are reduced at constant film thickness by a reaction with the underlying niobium and that they are oxidized by a reaction with oxygen from the gas phase. The reaction steps at the phase boundary are rate-determining. The kinetics was followed at temperatures less than 230°C by measuring the electronic conductivity, which is determined by the oxygen deficit in the oxide. The electronic conductivity at room temperature changed by 8 decades, although the concentration of oxygen vacancies may only vary by less than 5 decades. The unexpectedly large changes of conductivity are mainly due to the activation energy of the conductivity decreasing with the concentration of vacancies. (auth)

39705 FUNDAMENTALS AND RECENT DEVELOPMENTS IN THE FIELD OF HARD MATERIALS OF METALLIC AND NON-METALLIC ORIGIN. Kieffer, R.; Ettmayer, P. (Technische Hochschule, Vienna). Chem.-Ing.-Tech.; 42: 589-99(May 1970). (In German).

A review of various points of hardness theory is presented along with discussions of recent developments in the field of sintered hard alloys. It is noted that hafnium carbide has proved of value as a component of hard metals. Niobium carbide can replace the more expensive tantalum carbide in some applications; vanadium carbide inhibits grain growth, above all in ultrafine carbides. Results of studies on three- and four-component systems made up of TiC, HfC, NbC, TaC, and WC are briefly described. Sintered nitride and carbonitride hard metals appear to have some potential for machine tools. Newly developed high-pressure/high temperature autoclaves make possible fundamental studies of nitride systems under high nitrogen pressures. Comment is included on recent results concerned with non-metallic hard materials and diamond synthesis. (auth)

39706 THERMAL DIFFUSIVITY MEASUREMENTS OF HYPOSTOICHIOMETRIC URANIUM DIOXIDE AND URANIUM-PLUTONIUM OXIDE BY A MODULATED ELECTRON BEAM TECHNIQUE. Serizawa, M.; Kaneko, H.; Yokouchi, Y.; Koizumi, M. (Power Reactor and Nuclear Fuel Development Corp., Tokai, Japan). pp 549-67 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

Apparatus is described for the determination of the thermal diffusivity by the measurement of the phase difference between the temperature fluctuations at two faces of a thin plate of material, when the applied heat by an electron gun is modulated sinusoidally. The approximate equation of the relation between phase difference and thermal diffusivity of a ceramic is obtained so that thermal diffusivity of ceramics may be measured at high temperature without direct measurements of heat loss parameters. The diffusivity measurements were made on hypostoichiometric UO_2 and uranium–plutonium oxide of which the weight percent of plutonium dioxide was 10, 15 or 20. The calculated thermal conductivity of the uranium–plutonium oxide specimens using the specific heat was identical to each other within the experimental errors and could be expressed as $(W\,m^{-1}K^{-1}) = (9.388 \times 10^{-2} + 1.58 \times 10^{-6})^{-1}$, where T is in K. The calculated thermal conductivities of hypostoichiometric UO_2 were smaller than that of nearly stoichiometric UO_2 from 1,000 up to 1,400°C and showed an increase above 1,600°C. The results for the thermal diffusivity and the thermal conductivity of MgO and stoichiometric UO_2 as standard specimens from 900 up to 1,700°C were also obtained from this method and apparatus with an estimated accuracy of ±10%. The measured thermal conductivities of MgO and stoichiometric UO_2 are in good agreement with the reference values. (auth)

39707 THERMAL AND ELECTRICAL CONDUCTIVITIES OF SOME METALLIC COMPOUNDS. Powell, R. W.; Tye, R. P. (National Physical Lab., Teddington, Eng.). pp 575-83 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

Some new data are presented for the thermal conductivities and/or electrical resistivities of zirconium and silicon carbides, silicon nitride and of several cermets. The materials that are good electrical conductors all yield high values for the Lorenz function and the marked differences in the temperature dependencies of the derived values of the electronic and lattice contributions to the thermal conductivity are discussed. The lattice components of zirconium carbide, a cermet of cemented tungsten carbide (54%) with titanium carbide (25%), niobium and tantalum carbides (15%), cobalt (4%) and nickel (2%) and cermets of titanium carbide with 40% nickel, 50% nickel or 40% cobalt all resemble titanium carbide and cesium sulfide in being nearly temperature independent; also their electronic components increase with temperature. The cemented tungsten carbide cermets with additions of 20 and 6% cobalt, on the other hand, tend to resemble titanium diboride and zirconium diboride (above 200°C) in that the electronic component is fairly temperature independent while the lattice component decreases with increase in temperature. The lattice component of the cemented tungsten carbide with 6% cobalt is very large, and at room temperature exceeds the electronic component by about 60%. Similar studies do not appear to have been made for tungsten carbide, but the indications are that this material will be found to have a still larger lattice component. (auth)

39708 THERMAL CONDUCTIVITY OF YTTRIUM OXIDE IN THE TEMPERATURE RANGE OF 600 TO 2100 K. Chekhovskoi, V. Ya.; Stavrovskii, G. I.; Pustil'nik, A. I.; Sedykh, T. S.; Ivanov, A. B. (Inst. for High Temperature, Moscow). pp 605-8 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

Results of an experimental study of thermal conductivity of yttrium oxide in the temperature range of 600 to 2100°K are reported. Measurements of thermal conductivity were performed by the steady-state cylinder method. The specimens were prepared by pressing yttrium oxide powder with plasticizer and by sintering at 1600°C. Rare-earth metals oxides, present as impurities, amounted to about 1.6%. The bulk density of sintered specimens was 3.75 grams per cu cm whereas apparent porosity totaled 25.4%. (auth)

39709 THERMAL CONDUCTIVITY MEASUREMENT OF RADIOACTIVE MATERIALS USING THE HEAT PRODUCED BY DECAY. Posey, J. C.; Ketchen, E. E. (Oak Ridge National Lab., Tenn.). pp 761 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

Radioisotopes are being used increasingly as sources of heat in thermoelectric generators and thermionic converters. These devices have been used to power aids to navigation and remote weather stations. Radioisotope heat sources have the advantage of large power output per unit volume and longer useful lives than most competing sources of power for anticipated applications in remote terrestrial, aerospace, and marine environments. Furthermore, several radioisotopes will soon be available in very large quantities as by-products of the production of electrical power in nuclear reactors. Accurate thermal conductivity data are required for designing these heat sources. Several techniques have been devised for measuring the thermal conductivity of radioactive materials by using the heat produced by decay. Heat, generated throughout the interior of the source, must flow to the surface to escape. Consequently, the interior is hotter than the surface. (This interior temperature is often the limiting factor in heat source designs.) These internal temperature gradients can be used for measuring the thermal conductivity. Equations can be easily derived relating the thermal conductivity, dimensions, and power density with the temperature gradients in source forms of simple geometric shapes. However, the fabrication of thermal conductivity specimens is very difficult due to the intense radiation emitted, and all operations must be carried out by remote control in manipulator cells. Also, the extremely high temperature produced by the self-generated heat in some cases makes it difficult to handle the specimens. The feasibility of measuring the thermal conductivity by using the heat produced by decay has been demonstrated by measuring the thermal conductivity of $^{90}SrTiO_3$. All of the techniques investigated are not applicable to all materials because of various power densities, availability of material, and difficulties in fabricating suitable samples. Measurements of the thermal conductivities of several materials of differing power densities are planned. Several techniques for measuring thermal conductivity using the heat produced by decay are discussed. (auth)

39710 THERMAL DIFFUSIVITY AND CONDUCTIVITY OF SINTERED URANIUM–THORIUM MIXED OXIDES. Ferro, C.; Moretti, S.; Patimo, C. (Comitato Nazionale Energia Nucleare, Rome). pp 815-22 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

The thermal conductivity of 1%, 4%, 10% UO_2-ThO_2 sintered pellet and extruded oxides was measured in the temperature range 1500°C and compared with UO_2 values. The flash technique was applied to determine the thermal diffusivity, and literature data were used for specific heat and density of materials. The porosity effect of the different samples was considered on calculating the thermal conductivity values. Experiments were carried out by means of an apparatus consisting mainly of a high vacuum furnace, a laser as a source of energy pulses and a lead-sulfide cell as a temperature transient detector. The consistency of the values obtained with the literature data and some of the contemporary theories on mixed oxides thermal conductivity are discussed. (auth)

39711 TRANSIENT SYSTEM FOR MEASUREMENT OF THERMAL PROPERTIES OF NUCLEAR FUEL POWDERS OF VARYING DENSITIES. Schilmoeller, Neil H.; White, David (Argonne National Lab., Ill.). pp 857-70 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

A transient system to measure the thermal conductivity and thermal diffusivity of packed bed systems has been built and is currently being tested. Feasibility of this system is being demonstrated by measurements on magnesia and on uranium dioxide of several particle sizes and densities. Motivation for these measurements comes from interest in the use of vibratory compaction techniques for plutonium bearing nuclear fuel element fabrication. Extensive thermal property studies showing the effects of density, particle size and of other parameters will be needed if fuel elements are to be designed using these processes. The method suggested for this measurement borrows a scheme used by Harmathy on building materials. The system developed for packed bed materials uses a thin foil constantan heater for a constant heat flux source and thin foil thermocouples as temperature sensors. The test section is fabricated from lava and fired to provide a sturdy compartment in which to vi-pack the material being tested. The mathematical analysis follows Harmathy's lead in that a semi-infinite solid is assumed to obtain a solution to the time dependent diffusion equation. Experiments conducted so far have included measurements on several sizes of UO_2 particles as well as several different densities. These densities were obtained by infiltrating finely screened UO_2 particles into a bed of larger particles. Angular particle materials, i.e., crushed and screened, were used to obtain the material for the density variation tests. Data are also reported on one size of spherical UO_2 material. Results from tests using magnesia have been included in the reported measurements in an effort to provide a standardization of the experimental apparatus. (auth)

39712 PHYSICAL PROPERTIES OF BORIDE PHASES OF NIOBIUM. Kovenskaya, B. A.; Serebryakova, T. I. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 79-82(May 1970). (In Russian).

The results of investigating electrophysical properties of boride phases of different composition in the system Nb–B (Nb_3B_2, Nb_3B_4, NbB, NbB_2) are presented. The data are discussed taking into account the electronic structure of phases. (auth)

39713 CHEMICAL PROPERTIES OF LANTHANOID BORIDE POWDERS. Kosolapova, T. Ya.; Domasevich, L. T. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 1-5(May 1970). (In Russian).

The stability of rare-earth metal borides was investigated in different corrosive media. The borides of rare-earth metals are dissolved by nitric acid of various concentrations, and are stable in sulfuric and hydrochloric acids even with additives of complexing agents. (auth)

39714 AMBIENT AND HIGH TEMPERATURE EXPERIMENTS ON BORON-DOPED POLYCRYSTALLINE GRAPHITES. Wagner, P.; Dickinson, J. M. (Los Alamos Scientific Lab., N. Mex.). Carbon; 8: 313-20(Jun 1970).

Physical properties were measured as functions of B content and temperature for a series of extruded, resin bonded graphites. The B concentration range considered was from 0 to 0.79 wt %; up to at least 0.16% the solubility appears to be substitutional. Effects of the B at room temperatrue were determined for lattice spacing, elastic modulus, electrical resistivity and thermal conductivity. Temperature effects on electrical resistivity and thermal conductivity are reported to 2500°C and for coefficient of thermal expansion to 645°C. The observed results are discussed in qualitative terms and appear to be self-consistent. B exhibited a surprisingly strong effect on the thermal conductivity: an addition of 0.1% B reduced the room temperature λ by ~20% although the electrical conductivity was simultaneously increased. Temperature effects on the electrical resistivity vary in a complex manner with B concentration and it is of interest to note that at 0.081% B the electrical resistivity was found to be stable and constant within about ±3 per cent over the temperature interval 25 to 2500°C. (auth) (UK)

39715 MICROHARDNESS OF SILICON-CONTAINING PYROLYTIC CARBON. Tukovic, A.; Marinkovic, S. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). J. Mater. Sci.; 5: 541-5(Jul 1970).

The silicon-containing pyrocarbon (PC) deposited from CH_4-$SiCl_4$ gas mixture at 1150 to 1630°C and 50 to 200 torr total gas pressure exhibits great variations in microhardness. Low-Si PC has a very low hardness, slightly higher than pure PC. The hardness of PC with high Si-content is increased and closely related to its microstructure. An increased, uniformly distributed hardness is found in high-Si PC with a homogeneous microstructure, similar to that of pure PC. On the contrary, in the samples with non-uniform microstructure, very large cones growing from lenses were found to exhibit high hardness, which generally decreases along the cone axis from a value corresponding to that of pure SiC in the lens, to relatively low values that may approach that of pure PC. This observation, together with the fact that in the regions adjoining the large cones the hardness is low and approaches that of pure PC, proves that the Si in the form of SiC is concentrated in the large cones. A mechanism of large cone formation is proposed. (auth) (UK)

39716 APPARATUS AND PROCEDURE TO DETERMINE DENSITY AND STRUCTURAL DISTRIBUTIONS IN CARBONS AND GRAPHITES. Engle, G. B.; Norris, W. H.; Bailey, L. (Gulf General Atomic, Inc., San Diego, Calif.). Carbon; 8: 393-5 (Jun 1970).

The technique makes use of a standard density gradient apparatus adapted to separate and recover carbon or graphite particles according to their apparent density. Direct measurements of the recovered density fractions of a porous artificial graphite, fabricated using needle coke and impregnated with a non-graphitizing carbon, showed carbon structures ranging from semigraphitic to highly crystalline regions coexisting within a single solid specimen. (UK)

39717 DIFFUSION OF OXYGEN IN NITROGEN IN THE PORES OF GRAPHITE: THE EFFECT OF OXIDATION ON DIFFUSIVITY AND PERMEABILITY. Hewitt, G. F.; Moore, M. J. C.; Sharratt, E. W. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon; 8: 271-82(Jun 1970).

Experimental measurements are described on diffusivity and permeability of nuclear grade graphite. Nine carefully selected samples were progressively oxidized up to a maximum burn-off of 10 to 26%. It was shown that B_0 and K_0 (the permeability constants) and m (the ratio of diffusivity to free gas diffusivity) all increased progressively with increasing burn-off. At low percentage burn-off, the rate of increase of m was greater than that of the permeability constants. At 10% burn-off, the increase in all the constants was approximately threefold. A simple model was devised which qualitatively explains the results obtained. (auth) (UK)

Structure and Phase Studies

Refer also to abstract 40192.

39718 (NP-tr-1914) TITANIUM–CARBON–MOLYBDENUM (Ti–C–Mo). Eremenko, V. N. Translated by S. Dobriansky] (Broken Hill Proprietary Central Research Labs., Shortland, Australia), from pp 76-83 of Mnogokomponentnye Splavy Titana, Izd-vo AN UkrSSR, 1962. 9p. Dep. CFSTI (U. S. Sales Only).

Results of investigations of the ternary system, Ti-C-Mo are reviewed. From these investigations, and thermodynamic considerations, it is concluded that the TiC-Mo section is quasi-binary; this is verified experimentally. (Australia)

39719 THE STRUCTURE OF $\beta-U_3O_8$. Loopstra, B. O. (Reactor Centrum Nederland, Petten). Acta Crystallogr., Sect. B; 26: 656-7(1970).

The structure of $\beta-U_3O_8$ was determined from neutron-diffraction powder data. The oxygen coordination was a pentagonal dipyramid for two uranium atoms; for the third it was a deformed octahedron. (auth)

39720 NEUTRON-DIFFRACTION STUDY OF TmC_2 AT 300 TO 1.7°K. Atoji, Masao (Argonne National Lab., Ill.). J. Chem. Phys.; 52: 6431-3(15 Jun 1970).

$TmC_{2.00}$ was prepared and neutron diffraction patterns were taken with 1.069-Å neutrons at 300, 79, 5, and 1.7°K. The atomic positions are $(0,0,0; \frac{1}{2},\frac{1}{2},\frac{1}{2}) \pm (0,0,z)$ in $D_{4h}^{17} - I4/m$ mm with $z_{Tm} = 0$. The neutron coherent scattering amplitude is $b_{Tm} = 0.723$, $z_C = 0.3945$ and $2B = 1.92$ and 0.83 at 300 and 5°K, respectively. An R-factor contour map shows that a slight deviation in z_c causes a large uncertainty in the b_{Tm}. The interatomic distances are C–C = 1.279 Å, C–Tm = 2.392, and C–4 Tm' = 2.625 at 300°K. The paramagnetic scattering is modulated by a broad hump centered at 0.080 $Å^{-1}$ at 77°K. If magnetic long-range ordering is occurring at 1.7°K, the ordered moments should be less than 0.3 μ_B in ferromagnetic alignment and less than 0.6 μ_B for HoC_2-type ordering. (D.L.C.)

39721 NEUTRON-DIFFRACTION STUDY OF YbC_2 AT 300 TO 2°K. Atoji, Masao (Argonne National Lab., Ill.); Flowers, R. H. J. Chem. Phys.; 52: 6430-1(15 Jun 1970).

A low-temperature neutron-diffraction study of YbC_2 was made as part of systematic structure studies of REC_2. $YbC_{2.00\pm0.01}$ was prepared from a mixture of Yb and graphite, and neutron powder diffraction patterns ($\lambda = 1.069$ Å) were taken at 300, 77, 5, and 2°K. The lattice constants are a = 3.630 and c = 6.101 Å at 300°K and a = 3.625 and c = 6.099 Å at 5°K. The linear thermal expansion coefficients are 5×10^{-6}/deg and 1×10^{-6}/deg for a and c axes, respectively. The C positions in YbC_2 are $(0,0,0;\frac{1}{2},\frac{1}{2},\frac{1}{2}) \pm (0,0,z)$ with $z_c = 0.3940$. The coherent neutron scattering amplitude of Yb is $b_{Yb} = 1.290 \times 10^{-12}$ cm. The interatomic distances are C–C = 1.291 Å, C–Yb = 2.405 Å, and C–4 Yb' = 2.647 at 300°K. The paramagnetic diffuse scattering at 300°K is strongly modulated near 5°K. (D.L.C.)

39722 VALUES OF THE DISTANCES (Ln-X)n FOR THE LANTHANIDES IONS IN COORDINANCE n WITH OXYGEN, SULFUR, AND SELENIUM. Poix, Paul (Paris Univ., Orsay, France). Compt. Rend., Ser. C; 270: 1852-3(8 Jun 1970). (In French).

The coordinations 6, 8, and 12 for the oxygen anion, 6 and 8 for those of sulfur and selenium are considered in the given values of the "anion-cation" (Ln-X)$_n$ distances. (auth) (France)

39723 PHASE RATIOS IN THE SYSTEMS OF BARIUM OXIDE–OXIDES OF CERIUM SUBGROUP REE. Lopato, L. M.; Lugin, L. I.; Shevchenko, A. V. (Inst. of Problems in Material Studies, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B; No. 6, 535-9(Jun 1970). (In Ukrainian).

Annealing, tempering, and DTA methods were used to obtain data for the diagrams of state for the systems La_2O_3—BaO and Pr_2O_3—BaO in a concentration region from 0 to 90 mol. % BaO in the temperature range of 1300 to 2350°C. The samples of the compositions 2:1, 1:1, 2:3 and 1:2 were studied in the systems Ce_2O_3—BaO and Nd_2O_3—BaO. It is established that in all these systems there exists one compound of the composition 1 : 1 which is isotypical to calcium ferrite. The effect of the barium oxide additions was investigated on the character of temperature change of polymorphous transformations A → H and H → X of lantharum praseodymium oxides. (auth)

Radiation Effects

Refer also to abstracts 39085, 40895, and 41070.

39724 (BMI–1884) PROGRESS ON HIGH-TEMPERATURE FUELS TECHNOLOGY DURING FEBRUARY–APRIL 1970. Quarterly Report, Task 6. Keller, Donald L.; Chubb, Walston (Battelle Memorial Inst., Columbus, Ohio). May 1970. Contract W-7405-eng-92. 65p. Dep. CFSTI.

The gas pressure in the plenum of a 90 percent dense specimen of UO_2 operating at a surface temperature of 1525°C remained constant at 23 psi to a burnup of 0.27×10^{20} fissions per cm^3. At that burnup the pressure began to rise at a rate indicating essentially 100 percent gas release to a pressure of 42 psi at a burnup of 0.63×10^{20} fissions per cm^3. The delay in the onset of gas release is tentatively ascribed to a need for time to develop channel-type porosity suitable for releasing fission gas. A second capsule loading of UN specimens irradiated at temperatures of 1400 to 1600°C has shown external volume increases of less than 4 percent at a burnup of about 2.1×10^{20} fissions per cm^3. This material was maintained nitrogen-rich with an overpressure of nitrogen gas. Because of the small volume changes, no external effect of porosity or of grain size was distinguishable. However, as noted last quarter, microstructural examination disclosed a strong tendency for porosity to develop preferentially in the grain boundaries of the UN. An isolated instance of preferential separation of the grains along circumferential grain boundaries is attributed to a lack of restraint and to preferential deformation in the radial direction. Tensile creep tests of UN show an elongation to fracture of 11% at 1400°C in 344 hr at 5000 psi and an elongation of 4% at 1700°C in 10 hr at 1700 psi. This compares with the behavior of UC which showed an elongation to fracture of 37% at 1400°C in 800 hr at 5000 psi and an elongation of 17% at 1700°C in 7 hr at 3000 psi. (auth)

39725 (UNC–5259) FAST REACTOR MIXED-CARBIDE FUEL ELEMENT DEVELOPMENT PROGRAM. Eleventh Quarterly Progress Report, January–March 1970. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). May 1970. Contract AT(30-1)-3415. 44p. Dep. CFSTI.

Three helium-bonded high-density (UPu)C + 10 vol % $(UPu)_2C_3$ fuel rods were discharged from the EBR-II after accumulating a burnup of 73,000 MWd/t at 20 kW/ft. The results of the destructive post-irradiation examination of Type 316 stainless steel- and Incoloy 800-clad fuel rods irradiated to 40,000 and 57,000 MWd/t are given. Sintered high-density plutonium carbide–uranium carbide pellets were prepared. A parametric study is being performed to evaluate mixed carbides under transient conditions. (G.M.C.)

39726 RADIATSIONNOSTIMULIROVANNYE PROTSESSY V TVERDYKH TELAKH. (Radioinduced Processes in Solids). Niyazova, O. R. (ed.). Tashkent; Izdatel'stvo FAN Uzbekskoi SSR (1969). 164p.

Excited states of solids, structural defects, chemical bond distortion and ionization processes induced by nuclear irradiation were studied. The mechanism of radiation-induced damage and the means for preventing it are analyzed. Radioinduced heterodiffusion in silicon, radiolysis and damage in CdS, $BaCl_2$, and Rochelle salt crystals are discussed. The strength of γ-irradiated As_2S_3, radiosorption of O_2 on CdS, photomechanical effects in irradiation GaAs were examined. Radiation resistance of transistor instruments in reactor fields and uses of nuclear radiation for controlled changes in physical properties of polymer cable insulation are described. (R.V.J.)

39727 RADIATION DAMAGE. Thomas, G. (Univ. of California, Berkeley). Micron; 1: 248-54(Dec 1969)

1st National Conference on Current Developments in High Voltage Electron Microscopy, Monroeville, Pa. See CONF-690643.

The effects that reduction in ionization damage has had in increasing the range of materials which can now be examined by HVEM are discussed. Seven papers were presented: (1) displacement damage in the high voltage electron microscope. Makin, M. J. (Atomic Energy Res. Estab., Harwell, Eng.). A comprehensive review of electron radiation damages and its consequences in HVEM was given and it was stated that the critical energy for displacement is a function of the binding energy of the atom in the crystal and therefore a function of the crystal orientation; (2) electron irradiation damage in graphite. Ohr, S. M. (Oak Ridge Nat., Lab., Tenn.). In situ observations of clustering of radiation damage in single crystal as well as pyrolytic graphite in a 200 kV electron microscope were described; (3) high voltage electron microscope radiation damage of iron–carbon alloys. Thomas, L. E. (U. S. Steel Corp., Penn.); (4) high voltage electron microscope radiation damage of polymers. Thomas, L. E., Humphreys, C. J., Duff, W. R. (U. S. Steel Corp. Penn.). Observations on several electron displacement damage and beam heating effects in high-purity zone-refined iron and iron containing carbon in solution were reported; (5) precipitate coherency loss observed in the high voltage electron microscope, Woolhouse, G. R. (Univ. of Alberta). This work was reported in Nature 220: 573(1968); (6) electron radiation damage of organic materials. Kobayashi, K. (Kyoto Univ. Japan). The extreme sensitivity of some organic materials such as for example the polyethylenes to electron irradiation compared to metal or inorganic materials was emphasized; and (7) wide angle electron diffraction with beam sensitive biomolecular crystals. Glaeser, R. M. (Univ. of California). Examples were given of the limitations of observation of crystalline biological materials such as catalase l-valine, etc., which became damaged at 100 kV and below, as evidenced by changes in the diffraction pattern. (UK)

39728 PROPERTIES OF ABSORBENT CARBONS FOR FAST REACTOR SHIELDING. Cledat, J. (Societe Le Carbone Lorraine, Paris); Gremion, R.; Rappeneau, J.; Degas, P. Carbon; 8: 297-311(Jun 1970). (In French).

Different types of absorbent carbons containing rare earths or boron (calcium metaborate or boron nitride) were prepared for the neutron shield of fast neutron reactor PHENIX. The manufacture and the physical properties of these absorbent carbons are described. The changes of physical properties by neutron irradiation were determined at the irradiation temperature of 600°C and for doses up to 2×10^{21} n/cm^2. (auth) (UK)

39729 VACANCIES AND INTERSTITIAL CLUSTERS IN IRRADIATED GRAPHITE. Hinman, George W.; Haubold, Axel; Gardner, J. O.; Layton, James K. (Gulf General Atomic, San Diego, Calif.). Carbon; 8: 341-51(Jun 1970).

Experiments were carried out to measure vacancy concentrations, interstitial clusters, and dimensional changes in single crystals of graphite bombarded by neutrons and carbon ions. Bombardment temperatures varied from 20 to 1300°C. The variations of defect concentrations with temperature, displacement rate, and total displacements per lattice site are only partly understandable in terms of the present model of radiation damage in graphite. The studies of dimensional change show that single crystal graphite is very stable under irradiation at high temperature. (auth) (UK)

Plastics and Other Materials

Refer also to abstracts 38910, 38915, 38918, 39141, 39390, 39727, 40883, 40886, 40888, 40895, and 41006.

39730 (BNL-50218) CONCRETE-POLYMER MATERIALS. Second Topical Report. Steinberg, M.; Kukacka, L. E.; Colombo, P.; Auskern, A.; Manowitz, B. (Brookhaven National Lab., Upton, N. Y.); Dikeou, J. T.; Backstrom, J. E.; Hickey, K. B.; Rubenstein, S.; Jones, C. W. (Bureau of Reclamation, Denver, Colo.). Dec 1969. 73p. (REC OCE-70-1). Dep. CFSTI.

Activities are reported in a program established between the U. S. Bureau of Reclamation and BNL to investigate and develop concrete-polymer composites as improved building materials. Information is presented concerning monomer selection, polymer formation, preparation and properties of concrete-polymer composites, basic research, process and quality control, and applications development. (G.M.C.)

39731 (DP-Report-78) SOME TESTS ON P.T.F.E. VALVE SEATS. Project DRAGON. Harper, C.; Humphries, J. W.; Husain, L. A. (Atomic Energy Establishment, Winfrith (England)). Mar 1962. 19p. Dep. CFSTI.

Results of tests on the creep and sealing properties of the polytetrafluoroethylene (PTFE) component of a $\frac{1}{2}$ in. nominal core valve are described. The results indicate that this material is likely to prove satisfactory up to a PTFE nominal compressive stress of 2500 lb/in.^{2} and temperature of 58°C. (auth)

39732 (DP-Report-102) THE BOILING OF LIQUID NITROGEN IN CYLINDRICAL VESSELS. Project DRAGON. Voice, E. H. (Atomic Energy Establishment, Winfrith (England)). Jun 1962. 11p. Dep. CFSTI.

Experiments performed to estimate the influence of heat input on the volume increase of boiling nitrogen columns of various depths and diameters are described. (auth)

39733 (PRNC-135, pp 123-9) CHANGES OBSERVED IN CERTAIN MEXICAN WOODS CAUSED BY THE EFFECTS OF GAMMA RADIATION. Galvez-Cruz, L.; Echenique, R.; Burillo, G.; Salinas, R. (Universidad Nacional Autonoma de Mexico, Mexico City). (In Spanish).

From Radiation and isotope technology in Latin American development.

For some years, investigators from different countries have studied the changes in wood exposed to radiation, since alterations have been noted in their chemical and mechanical properties, resistance to attacks from microorganisms and parasites, as well as in their morphological structure. In general, the beneficial changes which increase mechanical properties and resistance to fungus are manifested with radiation doses of about 1×10^3 roentgens. This study was made to determine the effects of gamma radiation on wood from six species of trees found in Mexico i.e., Abies religiosa, Pinus rudis, Platymiscium yucatanum, Bursera simuraba, Quercus bervinervis and the Pouteria campechiana. (auth)

39734 (PRNC-135, pp 152-5) CONCRETE-POLYMER COMPOSITE MATERIALS. Steinberg, M.; Kukacka, L. E.; Colombo, P.; Manowitz, B. (Brookhaven National Lab., Upton, N. Y.).

From Radiation and isotope technology in Latin American development.

The preparation, testing, and development of concrete-polymer composites as an improved material of construction are under investigation in a joint program being carried out by Brookhaven National Laboratory and the U. S. Bureau of Reclamation with the support of the Division of Isotopes Development of the U. S. AEC, the Office of Saline Water, and the U. S. Bureau of Reclamation. The studies include the development of methods of preparation of both preformed and premixed concrete-polymer composites. The preparation technique for preformed concrete consists of drying, evacuating, monomer soaking, coating, and in situ polymerizing the monomer either by ^{60}Co gamma radiation, by thermalcatalytic initiation, or by a combination of both. For the premix concrete either part of the water is replaced with monomer or monomer is added to the fresh concrete mix. The mix is subsequently radiation or thermally treated. The results obtained to date including observations on strength, elasticity, cost, durability, and possible applications are reviewed. (auth)

39735 HEMATITE CONCRETE FOR SHIELDING FROM HIGH NEUTRON FLUXES. Dubrovskii, V. B.; Ibragimov, Sh. Sh.; Korenevskii, V. V.; Ladygin, A. Ya.; Pergamenshchik, V. K.; Perevalov, V. S. At. Energ. (USSR); 28: 258-60(Mar 1970). (In Russian).

Samples of hematite concrete, hematite ore and Portland cement were subjected to integral neutron fluxes up to 7×10^{20} neutrons/cm^2. Hot and cold control samples were set up. The cold control samples were held at 20°C and a humidity of 60% over the entire irradiation period, while the hot control samples received the same temperature treatment that the irradiated samples received. Irradiation of hematite concrete with a neutron dose up to 2.6×10^{20} neutrons/cm^2 (irradiation temperature of 250°C) leads to a 1.2 to 1.5% expansion of the samples. On increasing the neutron dose to 6×10^{20} and the temperature to 350 to 400°C, the expansion decreased to 0.7 to 0.9%. The control samples showed no change in linear dimensions. The thermal conductivity fell to 0.45 to 0.55 kcal/m · hr · °C from 0.6 to 0.8 kcal/m · hr · °C in the hot control samples. The strength and modulus of deformation of the irradiated and of the hot control samples were 10 to 15% lower than in the cold control samples. The samples lost moisture at higher irradiation temperature. Analogous changes were observed in hematite ore and Portland cement. Hematite concrete can be recommended as a neutron shielding material at integral neutron fluxes up to 7×10^{20} neutrons/cm^2. Its behavior at higher neutron fluxes requires further experimental study. The design should allow for moderate expansion to prevent stresses and cracking. (TTT)

39736 HIGH-TEMPERATURE THERMAL CONDUCTIVITY OF SOILS. Flynn, D. R.; Watson, T. W. (National Bureau of Standards, Washington, D. C.). pp 913-39 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

A description is given of an apparatus which was used to measure the thermal conductivity of soil samples at hot-side temperatures to 1600°C. The method utilizes radial heat flow in a hollow cylinder 1.3 cm inside diameter, 7.6 outside diameter, and 43 cm long. The outside of the sample is maintained near room temperature while the inside is heated to the desired temperature by means of a specially designed heater. The mathematical analysis of the method is given. Thermal conductivity values are given for nine natural or artificial soils which are representative of most of the subsoils found on earth. The method used shows considerable promise as a means of rapid and cheap generation of engineering data on the thermal conductivity of loose-fill materials. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstract 40330.

39737 GROWTH POINTS OF PHYSICS. Proceedings of the Florence Inaugural Conference of the European Physical Society, Florence, Italy, 8–12 April 1969. Riv. Nuovo Cim.; 1: Special No., 1-568(1969). (In French and English). (CONF-690421).

Separate abstracts were prepared for 19 of the 28 papers included. The remaining 9 papers are outside the scope of NSA. (J.W.R.)

For abstracts of individual papers see: 39742–39744, 39769, 39770, 39789, 39804, 39805, 39823, 39855, 39996, 40044, 40105, 40122, 40184, 40352, 40411, 40450, and 40704.

Cosmic Ray Exposure Ages

39738 ONCE MORE ABOUT FOSSIL PARTICLE TRACKS IN METEORITES. Kuchowicz, B. (Univ. of Warsaw). Urania (Krakow); 40: 237-41(1969). (In Polish).

As an addendum to an earlier published article further theoretical concepts are presented that refer to the question of superheavy elements in nature. According to suggestions of a group of theoreticians there may exist an additional island of stability in the vicinity of the magic proton number 114, though it is rather more probable that element 110 is more stable. There are some effects like the isotopic anomalies in Kr and Xe that may be explained in terms of a previous existence in meteoritic matter of a certain amount of fissile superheavy elements. Besides, it is well known that there are too many fossil tracks due to fission in meteorites. Thus, it may be that we have already some indirect evidence concerning the existence of elements with Z in the vicinity of 110. Such elements may be produced in a certain type of supernova explosion. (auth) (NSA of Poland)

Stars

Refer also to abstracts 39367, 39796, and 40517.

39739 (AD–704612) INVESTIGATION OF ECLIPSING BINARY SYSTEMS. Final Technical Report. Popper, Daniel M. (California Univ., Los Angeles). 20 Apr 1970. Contract Nonr-3507(00). 6p. CFSTI.

The principal aim of the program was to place the determination of stellar masses and radii, from analysis of eclipsing binary systems, on a sound observational basis. The approach was analysis of spectrographic material, supplemented by results from light curves. The systems analyzed included both those previously known to show the lines of both components, a necessary condition for mass determination, and those discovered in the program to have double lines. (auth) (USGRDR)

39740 (AD–704794) AN ATTEMPT AT RADIO OBSERVATION OF Ap STARS. Report No. 1970-2. Kodaira, Keiichi; Fomalont, Edward B. (Owens Valley Radio Observatory, Pasadena, Calif.). 1970. Contract N00014-67-A-0094-0008. 9p. CFSTI.

Twelve Ap stars were observed with a radio interferometer at 6.2 cm wavelength. An upper limit of radio flux was found for all of the stars. The absence of radio emission indicates a relatively steady electromagnetic nature for Ap stars. The amount of synchrotron radiation possible cannot produce the variable light and color of these stars. (auth) (USGRDR)

39741 (LA–4460-TR) A BETTER CALCULATION OF THE PERTURBATIONS OF STELLAR VELOCITIES (PROBLEM OF RELAXATION TIME). Henon, M. Translated for Los Alamos Scientific Lab., N. Mex., from Ann. Astrophys.; 21: 186-216(1958). 32p. Dep. CFSTI.

A new method is used for the computation of the perturbations of a test star in motion in an homogeneous isotropic stellar population. The influence of close stars is computed by the customary method: succession of single "collisions" to which the two-body problem formulae are applicable. The influence of far stars is computed, on the contrary, by a real method of perturbation, taking into account the fact that each star moves very little out of a linear trajectory. One shows that each method is entirely legitimate in its own field. The difficulty, ordinarily caused by the divergency of the integrals, disappears. One thus computes $\langle \Delta V_x \rangle$, mean perturbation of velocity; $\langle \Delta V_x^2 \rangle$, longitudinal dispersion; $\langle \Delta V_z^2 \rangle$, lateral dispersion (along a simple axis). The discussion shows that one must distinguish two phases in the evolution of the stellar population. (1) A phase of organization, during which the perturbations are increasing faster than the time. (2) A permanent regime, established after a time T_λ, in which the perturbations are increasing proportionally to the time. In the case where the masses of the test star and of the field-stars are of the same order of magnitude, one shows that the expressions given by Chandrasekhar for the perturbations have to be multiplied by $\frac{3}{2}$. The results are immediately valid for the similar problem of totally ionized plasmas. (auth)

39742 GRAVITATIONAL COLLAPSE: THE ROLE OF GENERAL RELATIVITY. Penrose, R. (Birkbeck Coll., London). Riv. Nuovo Cim.; 1: Special No., 252-76(1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

The "classical" collapse picture as presented by general relativity is illustrated. Objections and modifications to this picture are considered. The main discussion is based on Schwarzschild's solution of the Einstein vacuum equations. This solution represents the gravitational field exterior to a spherically symmetrical body. (W.D.M.)

39743 HIGHLY CONDENSED MATTER IN STARS. Salpeter, E. E. (Cambridge Univ., Eng. Cornell Univ., Ithaca, N. Y.). Riv. Nuovo Cim.; 1: Special No., 328-33(1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

Equations of state of matter at very high density and zero temperature are discussed. The possible masses of zero-temperature stars, their stability, and their characteristic periods are described. Some specific theoretical problems about neutron stars which relate to supernova explosion and collapse are considered. (W.D.M.)

39744 PHYSICAL PROCESSES RELATED TO THE PROBLEM OF NUCLEOSYNTHESIS AT THE SURFACE OF STARS. Schatzman, E. (Institut d'Astrophysique, Paris). Riv. Nuovo Cim.; 1: Special No., 334-55(1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

Topics discussed include spectra, abundances, star formation and evolution, double-star evolution, stellar rotation, electromagnetic loss of angular momentum, electromagnetic activity, stellar cosmic rays, nuclear evidence of surface nuclear reactions, problems of efficiency, accelerating mechanisms, evolutionary processes, and heavy-element problems. (W.D.M.)

39745 STABILITY OF ULTRARELATIVISTIC STARS. Ipser, James R. (California Inst. of Tech., Pasadena). Astrophys. Space Sci.; 7: 361-73(Jun 1970).

Two new theorems are presented on the theory of the stability of highly relativistic stars. The first theorem states that a highly relativistic, spherical star is stable if and only if its adiabatic index (assumed to be constant in the interior regions) is greater than a certain critical value, Γ_{crit}, which depends in a specified way on the high-density equation of state. This critical value is analogous to the Newtonian value $\Gamma_{crit} = \frac{4}{3}$, but because of relativistic effects it is typically somewhat larger than $\frac{4}{3}$. The second theorem shows that, at high central densities, the curves of −(binding energy) vs. radius, $-E_B(R)$, for certain hot, isentropic sequences of stellar models must exhibit damped clockwise spirals. This spiraling reflects the onset of instability in one radial mode of pulsation after another as the central density increases along the sequence. (auth)

39746 URCA SHELLS IN DENSE STELLAR INTERIORS. Tsuruta, Sachiko (Smithsonian Astrophysical Observatory, Cambridge, Mass.); Cameron, A. G. W. Astrophys. Space Sci.; 7: 374-406(Jun 1970).

Thermal and vibrational energy losses due to URCA shells in stellar interiors are calculated. Analytic expressions are derived for semidegenerate, relativistic electrons. Results are given for more general cases calculated with a computer. The calculations are carried out for a large number of nuclei that may contribute to URCA energy losses in various stages of stellar evolution. An illustration is given of the cooling and vibrational damping of a white dwarf. For a central Fermi energy $\gtrsim 5$ MeV, the internal temperature of the star should be reduced to the order of 10^8 K and the relative vibrational amplitude should be reduced to the order of 10^{-5} on a time scale of 10^9 yr. The URCA energy losses are compared with other neutrino energy losses. In a stellar interior where URCA shells are present, the URCA neutrino en-

ergy loss dominates in the temperature region up to about 2×10^9 K. (auth)

39747 PLASMON NEUTRINOS EMISSION IN A STRONG MAGNETIC FIELD. I. TRANSVERSE PLASMONS. Canuto, V.; Chiuderi, C.; Chou, C. K. (Goddard Space Flight Center, New York). Astrophys. Space Sci.; 7: 407-15(Jun 1970).

The Adams, Ruderman, Woo, and Zaidi plasmon decay process is generalized to include the presence of a strong magnetic field. Two cases are studied; propagation parallel and perpendicular to the magnetic field. In either case it is found that relevant changes only show for $H \simeq 10^{12}$ to 10^{13} G. (auth)

39748 RELATIVISTIC ISENTROPIC STELLAR MODELS. Shaviv, G.; Kovetz, A. (Tel-Aviv Univ., Ramat Aviv, Israel). Astrophys. Space Sci.; 7: 416-23(Jun 1970).

Relativistic, isentropic, homogeneous models are constructed by a method that automatically detects instabilities, and evolutionary tracks of central conditions are shown on a (T,ρ) diagram. Models heavier than 20 $M_\odot$ become unstable because of pair creation. Iron photodisintegration causes instability in the mass range between 1.5 and 20 $M_\odot$. General relativistic effects bring about the onset of instability in models of 1.2 to 1.5 $M_\odot$ when the central density is about 10^{10} g/cm^3. Lighter models become white dwarfs. It is pointed out that general relativistic instability will prevent the formation of neutron stars through hydrostatic evolution and may be relevant in setting off low-mass supernovae. (auth)

39749 FORMATION OF STELLAR ASSOCIATIONS. Pikel'ner, S. B. (Sternberg Astronomical Inst., Moscow). Astrophys. Space Sci.; 7: 489-93(Jun 1970).

The Rayleigh-Taylor instability forms massive complexes. When 10^{21} atoms cm^{-2} are gathered, x rays that heat the gas and uv rays that ionize carbon are absorbed. A layer should appear with temperatures as low as 6°K and density to 4×10^3 cm^{-3}. Finally the layer is fragmented into stars whose masses may even be less than one solar mass. The temperature of the layer should increase with time because part of free carbon is gradually absorbed by dust. Therefore, more massive stars should appear after less massive stars. The stars formed are kept near the layer by its gravitation. When their total mass becomes comparable with the mass of the layer, they should fall to the galactic plane in agreement with observed proper motions of several stellar systems studied. (auth)

39750 SPACE DISTRIBUTION OF THE OB STARS IN CARINA. Graham, J. A. (Cerro Tololo Inter-American Observatory, La Serena, Chile). Astron. J.; 75: 703-17(Aug 1970).

Distances have been determined for 436 OB-type stars in Carina using new Hβ line-intensity measurements and spectral classifications. A sharp outside edge is found to the OB star distribution with respect to the center of the Galaxy. The layer of OB stars follows the galactic plane to distances of the order of 3kpc. The mean $|z|$ of the OB stars to this distance is 38.1 pc. At distances greater than 4 kpc, the layer appears to bend away from the plane to negative latitudes by 2 or 3° out to distances of the order of 10 kpc. This bending is possibly related to the similar bending found in the neutral hydrogen layer from 21-cm observations. (auth)

39751 ROTATIONAL VELOCITIES IN THE URSA MAJOR GROUP. Geary, John C. (Univ. of Arizona, Tucson); Abt, Helmut A. Astron. J.; 75: 718-20(Aug 1970).

Rotational velocities from coudé spectra are given or quoted for 49 members of the Ursa Major group. The mean rotational velocities agree well with those of field stars, making this the only known cluster in which this occurs. The unusually low mean rotational velocities for A1-A2 field stars seems to be attributable to an inconsistent sampling of abnormal stars. (auth)

39752 VZ HYDRAE. Walker, R. L. Jr. (Naval Observatory, Flagstaff, Ariz.). Astron. J.; 75: 720-4(Aug 1970).

VZ Hydrae is an eclipsing binary with detached components (P = 2.9d); it is also a double-lined spectroscopic binary. New photoelectric UBV light curves of this system were obtained in order to place its components accurately on the mass-luminosity (M-L) diagram. These light curves, along with the radial-velocity data by Popper (1965), show that both components lie about 0.3 mag above the Sun-Sirius M-L relationship as defined by Eggen (1965) and have uv excesses of +0.06 and +0.03 mag with respect to the Hyades. The masses and bolometric magnitudes of the individual components are: $\mathfrak{M}^{pri} = 1.23 \pm 0.03_\odot$, $\mathfrak{M}^{sec} = 1.12 \pm 0.03_\odot$, $M_{bol}^{pri} = 3.5 \pm 0.1$ m, and $M_{bol}^{sec} = 4.0 \pm 0.1$ m. (auth)

39753 ECLIPSING BINARY SYSTEM RW PISCIS AUSTRINI. Chambliss, Carlson R. (Georgetown Coll. Observatory, Washington, D. C. Cerro Tololo Inter-American Observatory, La Serena, Chile). Astron. J.; 75: 725-30(Aug 1970).

The eclipsing binary RW Piscis Austrini was observed photoelectrically in yellow and in blue light at Cerro Tololo. RW Piscis Austrini is a W Ursae Majoris-type eclipsing binary whose intrinsic color corresponds to that of a main-sequence star of spectral type G6. The major peculiarity of its light curve is the very large value of the coefficient of the cos θ term, A_1. Although this term ordinarily arises primarily from the differential reflection effect, this effect should be minimal in RW Piscis Austrini, where the minima are of roughly equal depth. The eclipses are not complete, and the solution for the orbital elements indicates that the two components are of roughly equal size and brightness. (auth)

39754 ECLIPSING BINARY SYSTEM BV 845. Chambliss, Carlson R. (Georgetown Coll. Observatory, Washington, D. C. Cerro Tololo Inter-American Observatory, La Serena, Chile). Astron. J.; 75: 731-8(Aug 1970).

The eclipsing binary BV 845 was observed photoelectrically in yellow and in blue light at the Cerro Tololo. BV 845 is a Beta Lyrae-type system with complete eclipses, the primary being a transit. The period of BV 845 is 0.537194888d, and despite the fact that more than 100 times minimum light covering nearly 70 years are available, there is no evidence for a change of period. Solutions are presented which are based on three different methods of rectification. These indicate that k is about 0.45. The solutions presented are based on the primary eclipse only, for the secondary eclipse yields contradictory and unacceptable solutions. BV 845 is clearly a severely complicated system. The duration of the complete portion of eclipse during secondary minimum is longer than that during primary minimum. As evidence is also presented for a small phase shift between the primary and secondary minima and for unequal values of external tangency, it is probable that the orbit of BV 845 is somewhat eccentric. However, physically one would not expect appreciable orbital eccentricity, for the two components are practically in contact. BV 845 is similar to the eclipsing binary DO Cas in many respects. The similarities and differences between these two systems are discussed. (auth)

39755 RADIATIVE TRANSFER IN A SPHERICAL ATMOSPHERE OF FREE ELECTRONS. Viik, T. (Inst. of Physics and Astronomy, Tartu). Izv. Akad. Nauk Est. SSR, Fiz. Mat.; 19: 184-95(1970).

In previous papers by the author (1968) expressions were presented for the emergent intensity in a spherical stellar atmosphere of free electrons. These expressions were obtained by following the techniques elaborated by Chandrasekhar (1948) and Münch (1948) for the case of $\alpha = 0$ and $\alpha \neq 0$, respectively. As the treatment of scattering in the author's papers was based on the over-simplified source functions, it was felt to be of interest to use the Pomraning equation in the case of a spherical stellar atmosphere in order to get a more reliable expression for the emergent radiation. The case considered is that of a pure electron scattering spherical atmosphere of finite thickness with an inner and outer radius. (W.D.M.)

39756 THE PECULIAR STAR CH CYGNI IN 1968. Luud, L. (Inst. of Physics and Astronomy, Tartu). Izv. Akad. Nauk Est. SSR, Fiz. Mat.; 19: 177-83(1970).

From previous results it can be stated that CH Cygni is gM6 with relatively strong additional hot continuum and emission lines of H, He I, Fe II, and [Fe II]. Photoelectric and spectral observations in 1968 are accounted for, and an attempt is made to explain the nature of CH Cygni. (W.D.M.)

39757 RADIO OBSERVATIONS OF α^2 CVn. Trasco, J. D. (Univ. of Virginia, Charlottesville); Wood, H. J.; Roberts, M. S. Astrophys. J.; 161: L129-31(Aug 1970).

Six-centimeter radio observations of α^2 CVn over the full cycle yield only an upper limit of 0.01 f.u. The result rules out a synchrotron mechanism for the optical light fluctuations. Observations of other optical objects are also reported. (auth)

39758 7 SEXTANTIS: AN OLD DISK HORIZONTAL-BRANCH STAR. Rodgers, A. W.; Wood, P. R. (Australian National Univ., Canberra). Astrophys. J.; 161: L145-8(Aug 1970).

Spectrophotometry of 7 Sex leads to a determination of an effective temperature of $\theta_e = 0.49$ and a surface gravity of log g = 3.45. The helium and iron abundances are found to be normal. The hypothesis that 7 Sex is an evolved runaway B star is shown to be inconsistent with the galactic orbital parameters. It is proposed that 7 Sex is an old disk horizontal-branch star. (auth)

39759 SOME SPECTROSCOPIC CHARACTERISTICS OF THE OB STARS: A NITROGEN ANOMALY. Walborn, Nolan R. (Univ. of Chicago). Astrophys. J.; 161: L149-52(Aug 1970).

During a spectroscopic investigation of the OB stars with a dispersion of 63 Å mm^{-1}, a number of stars were found in which the nitrogen lines are too strong or too weak for their spectral types. A striking case of a spectrum with N III enhanced, HD 201345, is illustrated and discussed, and other examples of this new class of peculiar OB stars are listed. (auth)

39760 INFRARED OBSERVATIONS OF THE NEBULA K3-50. Neugebauer, G. (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena); Garmire, G. Astrophys. J.; 161: L91-4 (Aug 1970).

Infrared observations of the nebula K3-50 show an energy distribution and apparent intensity which closely resemble those of NGC 7027 and W51-IRS 2. (auth)

39761 SCANNER OBSERVATIONS OF THE LEO INFRARED OBJECT IRC + 10216. Miller, Joseph S. (Univ. of California, Santa Cruz). Astrophys. J.; 161: L95-9(Aug 1970).

Scanner observations of IRC + 10216 in the spectral range 7000 to 11,000 Å indicate the presence of three absorption features identified as CN bands. It is suggested that the object is a carbon star surrounded by a dust cloud; the cloud is possibly a product of the star itself. (auth)

39762 INFRARED EMISSION OF NOVAE. Geisel, S. L. (Rice Univ., Houston, Tex.); Kleinmann, D. E.; Low, F. J. Astrophys. J.; 161: L101-4(Aug 1970).

Nova Ser 1970 and Nova Aql 1970 have become luminous infrared sources emitting energies greater than 10^{45} ergs at wavelengths longer than 2 μ. Similar infrared emission from Nova Del 1967, FU Ori, and RS Oph was observed. (auth)

39763 INFRARED EXCESSES, LOW-EXCITATION EMISSION LINES, AND MASS LOSS. Geisel, Susan L. (Rice Univ., Houston, Tex.). Contract F 19628-70-C-0046. Astrophys. J.; 161: L105-8 (Aug 1970).

A strong correlation between stars with low-excitation emission lines, especially Fe II, and stars with excess infrared radiation has been used to predict infrared excesses in thirty stars whose spectral emission features were known. Large-scale mass loss characterizes most of the seventy stars now known to emit excess infrared radiation, which suggests that all these stars have circumstellar envelopes in which rapid grain formation is occurring. (auth)

39764 DISCOVERY OF CIRCULARLY POLARIZED LIGHT FROM A WHITE DWARF. Kemp, James C. (Univ. of Oregon, Eugene); Swedlund, John B.; Landstreet, J. D.; Angel, J. R. P. Astrophys. J.; 161: L77-9(Aug 1970).

Strong circular polarization, 1 to 3%, was discovered in visible light from the semi-DC "peculiar" white dwarf Grw + 70°8247. This is the first such observation on any white dwarf, and is taken as indicating a strong magnetic field. From the theory of gray-body magnetoemissivity, to which the wavelength dependence of the circular polarization would appear to conform, one estimates a mean projected B field of 1×10^7 gauss. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

39765 (AD-704572) OBSERVATIONS OF OH RADIO EMISSION SOURCES. Ball, John A. (Massachusetts Inst. of Tech., Lexington. Lincoln Lab.). 23 May 1969. Contract AF19(628)-5167. 104p. CFSTI.

The 18-cm OH radio emission sources were studied to determine their character and their relation to other objects in the Galaxy. The Haystack and Millstone antennas were used with a 100-channel digital autocorrelator to obtain Stokes parameter spectra of many of the brighter sources. Time variations in the OH emission from some of these sources were detected and studied and maps of the regions around OH emission sources were obtained in the continuum near 2 and 4 cm. The Haystack-Millstone spectral-line interferometer was used to check the positions of a pair of OH emission sources and to search for angular variation in the OH absorption across Cas A. Evidence for phenomenological associations between OH emission and H II regions, supernovae remnants, and infrared objects is discussed, and a kinematic model of the OH emission sources presented. (auth) (USGRDR)

39766 (AD-704793) OPTICAL IDENTIFICATION OF RADIO SOURCES SELECTED FROM THE 4C CATALOG. Olsen, E. T. (Owens Valley Radio Observatory, Pasadena, Calif.). 1970. Contract N00014-67-A-0094-0008. 57p. CFSTI.

A total of 490 radio positions having an average error of plus or minus 20 seconds in both coordinates were studied optically in an attempt to identify the sources. The radio sources were selected from the 4C catalog and the optical search was carried out on the Palomar Sky Survey prints. Approximately one-third of the 204 identifications proposed are quasi-stellar objects. There is evidence that the plate limit of the sky survey is affecting the identification of galaxies. (auth) (USGRDR)

39767 (AD-704795) POLARIZED BRIGHTNESS DISTRIBUTION FOR 3C20. Report No. 1970-3. Fomalont, Edward B. (Owens Valley Radio Observatory, Pasadena, Calif.). 1970. Contract N00014-67-A-0094-0008. 19p. CFSTI.

High-resolution maps at 2695 MHz using the NRAO three-element interferometer were obtained for the linearly polarized and total radiation of 3C 20. The total radiation shows a common structure composed of two unresolved components with larger-scale radiation between them. The polarized distribution shows good correspondence with the total distribution. The intense components are only slightly polarized, while the central regions have polarizations as large as 20%. (auth) (USGRDR)

39768 ANGULAR BROADENING OF RADIO SOURCES BY SOLAR WIND TURBULENCE. Hollweg, Joseph V. (Max-Planck-Inst. fuer Physik und Astrophysik, Garching, Ger.). J. Geophys. Res.; 75: 3715-27(1 Jul 1970).

The observed apparent angular broadening of radio sources as they pass close to the sun is discussed in terms of statistical ray theory. Unlike earlier works in which the turbulent interplanetary plasma is assumed to possess a spectrum of Gaussian form, power spectra are treated for fluctuations in electron density, assumed to be of the same form as have been obtained for magnetic field and velocity fluctuations by in situ measurements. Such spectra are distinctly non-Gaussian. It is found that the data suggest that the solar wind turbulence is strong between 10 and 100 solar radii distance from the sun. This result disagrees with earlier analyses, which suggest that the fluctuations are of the order of only a few per cent of the mean, but it agrees with the large fluctuations in electron density indicated by direct satellite measurement near the orbit of the earth. The data usually imply that the solar wind electron density varies as r^{-2}, and that the correlation length and inner scale (that wavelength below which there is little power) of the turbulence are constant with distance from the sun. At times, however, the data imply that the electron density varies as $r^{-2.5}$, and the two length scales are constant; or that the density varies as r^{-2}, and the two length scales increase linearly with distance from the sun. (auth)

39769 PULSARS. Hewish, A. (Cavendish Lab., Cambridge, Eng.). Riv. Nuovo Cim.; 1: Special No., 122-33(1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

An attempt is made to summarize the present situation in the field of pulsars and to outline the basic evidence and the significance this provides for theoretical work. The observed properties of pulsars including periods and positions, pulse structure frequency-time variation, optical evidence, distances, and energies are discussed. The physical nature of pulsars is considered in terms of high-density matter, stellar evolution, and neutron star theory of pulsars. (W.D.M.)

39770 RADIOGALAXIES AND QUASI-STELLAR OBJECTS. Woltjer, L. (Columbia Univ., New York). Riv. Nuovo Cim.; 1: Special No., 515-20(1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

A brief summary of the problems in attempting to interpret the physical processes occurring in radio galaxies and quasars is presented. (W.D.M.)

39771 X-RAY SURVEY OF CENTAURUS A. Byram, E. T.; Chubb, T. A.; Friedman, H. (Naval Research Lab., Washington, D. C.). Science; 169: 366-8(24 Jul 1970).

An x-ray survey of Centaurus A has given marginal evidence of its x-ray flux. If taken as an upper limit on inverse Compton x rays generated by scattering interactions between relativistic electrons and cosmological background photons, the observation implies an upper limit of close to 3°K for the background radiation temperature. (auth)

39772 OBSERVATIONS OF POSSIBLY EXPANDING NEUTRAL-HYDROGEN SHELLS. Verschuur, G. L. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. J.; 75: 687-94(Aug 1970).

The distribution of neutral hydrogen in two isolated areas is consistent with the presence of expanding shells of gas. In both cases a pulsar is situated about 2 to 3° from the apparent center of the shells. These regions also show the presence of concentrations with large internal velocity gradients and clouds with very narrow line widths ($T_K \sim 30$°K). These data show that further high resolutions observations at high galactic latitudes are likely to

reveal much important information about the structure of the interstellar medium. Values for the integrated neutral-hydrogen density are given for ten pulsar directions. (auth)

39773 OPTICAL IDENTIFICATION OF RADIO SOURCES AT DECLINATIONS BELOW −45°. Bajaja, Esteban (Instituto Argentino de Radioastronomia, Buenos Aires). Astron. J.; 75: 667-71(Aug 1970).

The optical identification of radio sources in the Parkes Catalogue at declinations not covered by the Palomar Sky Atlas was attempted. Two hundred plates were obtained with the 61-inch telescope of the Córdoba Observatory. Finding charts are provided for 78 radio source positions; identifications for 15 radio sources are suggested. (auth)

39774 MASTER LIST OF RADIO SOURCES. Dixon, Robert S. (Ohio State Univ., Columbus). Astrophys. J., Suppl. Ser.; 20: No. 180, 1-503(Jul 1970).

A Master List of radio sources was prepared by combining about thirty catalogs in a common format. Approximately 25000 listings are included for some 12000 separate sources. The list is in order of increasing right ascension and is arranged for maximum utility and minimum complexity. Each entry gives the source name, 1950.0 position, flux density, and the frequency at which it was observed. This list will be maintained and updated indefinitely at OSURO, and magnetic-tape copies of the latest versions will be available at any time. (auth)

39775 18-CM OBSERVATIONS OF GALACTIC OH FROM LONGITUDES 350° TO 50°. Robinson, B. J.; Goss, W. M.; Manchester, R. N. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Aust. J. Phys.; 23: 363-404(Jun 1970).

OH emission and absorption for 15 sources were observed between galactic longitudes 350 and 50°. The four Stokes parameters of the OH emission were measured on all four 18-cm transitions. The emission was found to have a wide range of polarization and spectral characteristics. Positions were measured for the 12 OH sources that have not had their positions determined by interferometry of lunar occulations. The relationship of the OH to the background continuum was investigated from the positional information and from a comparison of OH radial velocities with recombination line velocities of the H II regions. Secular variations were observed in five cases. (Australia)

39776 OH ABSORPTION AT 1667 MHz NEAR THE GALACTIC CENTRE. Robinson, B. J.; McGee, R. X. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Aust. J. Phys.; 23: 405-23(Jun 1970).

Absorption by OH at 1667 MHz was measured for galactic longitudes between 357°30′ and 3°20′ and latitudes between +0°20′ and −0°40′. The results for $0°10' \geq \text{II} \geq -0°20'$ are presented as contours of absorption temperature in the longitude−radial velocity plane. A comparison with 1420 MHz observations of neutral hydrogen reveals many differences between the distributions and opacities of H and OH. The motions of the OH near the galactic nucleus differ markedly from those deduced from the H-line measurements. (Australia)

39777 LINEAR POLARIZATION OF RADIO SOURCES BETWEEN 11 AND 20-CM WAVELENGTH. III. INFLUENCE OF THE GALAXY ON SOURCE DEPOLARIZATION AND FARADAY ROTATION. Gardner, F. F.; Morris, D.; Whiteoak, J. B. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Aust. J. Phys.; 22: 813-19(Dec 1969).

The dependence of galactic latitude of the 11 and 20 cm polarization of 355 extragalactic sources reveals no definite evidence of depolarization within the Galaxy. The distribution of Faraday rotation can be explained in terms of a field along the local spiral arm, deformed by magnetic "loops" in the solar neighborhood. (Australia)

39778 IMPROVED POSITIONS AND SOME OPTICAL IDENTIFICATIONS FOR 451 4C RADIO SOURCES BETWEEN DECLINATIONS 4° AND 20°. Wills, D. (Texas Univ., Austin); Bolton, J. G. Aust. J. Phys.; 22: 775-812(Dec 1969).

Accurate positions have been measured at Parkes for 451 4C radio sources between declination 4 and 20°. For most of the sources the rms uncertainty is ±10″ arc in each coordinate. Optical identifications are suggested for 94 sources, of which 22 are galaxies and 72 are possible quasi-stellar objects. (Australia)

39779 LINEAR POLARIZATION OF RADIO SOURCES AT 6-CM WAVELENGTH. Gardner, F. F.; Whiteoak, J. B.; Morris, D. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Aust. J. Phys.; 22: 821-38(Dec 1969).

Linear polarization measurements at 6-cm wavelength with the Parkes 210-ft telescope are given for 706 sources. Comparison of polarization parameters and flux densities with other published data is made. For the variable sources it is found that changes in polarized flux and position angle can accompany changes in intensity. (Australia)

39780 DISCOVERY OF PULSAR PP 0943 BY MEANS OF THE DIFFERENCE METHOD. Zhuravlev, V. F. Priroda; No. 6, 66-8(Jun 1970). (In Russian).

The history and the methods used for discovering pulsar PP 0943 are reviewed. The installation of the radioastronomical station located 120 km south of Moscow is described, and the "differential method of pulsar recording" is discussed. (R.V.J.)

39781 PRECISE LABORATORY MEASUREMENT OF THE 4830-MHz FORMALDEHYDE ROTATIONAL TRANSITION. Tucker, K. D. (Columbia Univ., New York); Tomasevich, G. R.; Thaddeus, P. Astrophys. J.; 161: L153-4(Aug 1970).

The frequencies of the hyperfine components of the $1_{10} \rightarrow 1_{11}$ rotational transition of H_2CO were measured with a molecular-beam maser to an absolute precision of about 1 part in 10^8. (auth)

39782 ADDITIONAL PERIODIC VARIATIONS IN THE RADIATION INTENSITY OF PULSARS. Lang, Kenneth R. (Arecibo Observatory, Puerto Rico). Contract F44620-69-C-0092. Astrophys. J.; 161: L133-5(Aug 1970).

Power spectra of the intensity fluctuations of CP 0834, AP 1237, and CP 1919 show features corresponding to long periodicities ($P_4 \approx 100$ sec) and shorter periodicities ($P_3 \approx 5$ sec). The period equation $P_4 = P_1P_3/P_2$ predicts a P_4 which differs from these measurements by 50 and 340% for CP 0834 and CP 1919, respectively. The relative intensities and the widths of the spectral features corresponding to P_3 and P_4 vary with the time of observation. Analog records of CP 1133 and AP 1237 indicate that their P_4 is the result of a periodic switching mechanism of short duration and with sharp boundaries. The circulating-plasma model must be quite complicated if it is to account for this diverse set of observations. (auth)

39783 EXPANDING ENVELOPES OF THE QUASI-STELLAR OBJECTS PHL 5200 AND RS 23. Scargle, Jeffrey D. (Univ. of California, Santa Cruz. Ames Research Center, Moffett Field, Calif.); Caroff, Lawrence J.; Noerdlinger, Peter D. Astrophys. J.; 161: L115-21(Aug 1970).

The wide absorption troughs of certain resonance lines in the spectra of the QSOs PHL 5200 and RS 23 are produced by pure scattering and must therefore be compensated by an equal amount of emission. Analysis of the transfer of resonance-line radiation through a differentially expanding atmosphere shows that the absorption−emission profiles can be quantitatively understood on this basis. An evolutionary relation to narrow-line objects is suggested. (auth)

39784 FLUX DENSITIES OF TEN GALACTIC SOURCES IN THE MILLIMETER BAND. Downes, D.; Maxwell, A.; Rinehart, R. (Harvard Radio Astronomy Station, Fort Davis, Texas). Astrophys. J.; 161: L123-8(Aug 1970).

Measurements were made at 31.4 GHz, with a 36-foot radio telescope of beamwidth 3.5′, of the flux densities of Sgr A, G0.7−0.0 (Sgr B2), G10.2−0.4 (W31), M17, G30.8−0.0 (W43), G45.5 + 0.1, G49.5−0.4 (W51 A1), K3−50, DR 21, and NGC 7538. Flux measurements were also made of Sgr A and DR 21 at 85.0 GHz with the same antenna, at which frequency it has a beamwidth of 1.2′. The general characteristics of Sgr A and DR 21 are discussed. (auth)

39785 OBSERVATION OF THE CN RADICAL IN THE ORION NEBULA AND W51. Jefferts, K. B. (Bell Telephone Labs., Murray Hill, N. J.); Penzias, A. A.; Wilson, R. W. Astrophys. J.; 161: L87-9(Aug 1970).

Spectral features in emission in the directions of the Orion Nebula and of W51 were detected, which are attributed to the rotational transition $J = 1 \rightarrow J = 0$ in the cyanide radical. (auth)

39786 ALIGNMENT OF AN OBLIQUE SPHEROIDAL ROTATOR THROUGH ELECTROMAGNETIC AND GRAVITATIONAL RADIATION. Chau, W. Y.; Henriksen, R. N. (Queen's Univ., Kingston, Ont.). Astrophys. J.; 161: L137-43(Aug 1970).

The evolution of an oblique rotator with both gravitational and magnetic radiation included was studied. The most likely value for the present deceleration parameter n of the Crab pulsar was found to be in the range 3 to 3.5 if an eventual slowdown of the frequency to the 1-Hz range is to come about. (auth)

Solar Phenomena

39787 (AD-704552) SOLAR OBSERVATIONS AT 8.6-mm WAVELENGTH. Physical Sciences Research Papers. Kalaghan, Paul M.; Telford, Larry E. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Jan 1970. 52p. (AFCRL-PSRP-408; AFCRL-70-52). CFSTI.

The advent of manned space flights has focused attention on the biological threat posed by solar proton flares. In an effort to close one of the gaps in the observation of the solar spectrum, AFCRL has initiated a high-resolution millimeter-wavelength solar observation program. This report covers the observational approach and initial findings of this program based upon observations from May to December 1968. The equipment and procedures used to produce spectroheliograms at 8.6 mm, using the AFCRL 29-ft millimeter-wave antenna, are described. The quiet Sun at 8.6 mm appeared to have a brightness temperature of 8400 ± 600°K blackbody and a 'radio diameter' 3% greater than the optical disk. The presence of active regions during this period was characterized by localized enhanced regions exhibiting temperature increases from 1 to 28% of the quiet-Sun level. The enhancement and the positions of these regions were compared with 9.1-cm radio data and various other optical data. The locations of the 8.6-mm enhanced regions are contained within calcium plages. All proton events observed originated only in highly enhanced (Class III) regions. Further observations are in progress to increase the sample size of observed proton events to further refine the possibility of prediction of these events. (auth) (USGRDR)

39788 (AD-704564) RESEARCH ON EXTREMELY LOW FREQUENCY PROPAGATION WITH PARTICULAR EMPHASIS ON SCHUMANN RESONANCE AND RELATED PHENOMENA. Final Report, January 15, 1965-November 15, 1969 on Part I. Tran, Anh; Polk, Charles (Rhode Island Univ., Kingston. Dept. of Electrical Engineering). 28 Feb 1970. Contract AF19(628)-4950. 71p. (AFCRL-70-0143(Pt.1)). CFSTI.

Propagation characteristics of elf waves in interplanetary space between the Sun and the bowshock of the magnetosphere are considered for parallel propagation. It is shown that only the right hand circularly polarized transverse wave and the longitudinal ion-acoustic wave can propagate during normal quiescent conditions. However, damping is sufficiently high to make it unlikely that waves will be detected in the vicinity of the Earth at any appreciable distance. For perpendicular propagation, both ordinary and extraordinary modes are considered. (auth) (USGRDR)

39789 INTER-PLANETARY AND MAGNETOSPHERIC PLASMA. Schindler, K. (European Space Research Inst., Frascati, Italy). Riv. Nuovo Cim.; 1: Special No., 356-70 (1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

The discussion is divided into the interplanetary plasma, the magnetosphere, and neutral sheets. An attempt is made to outline the present state of knowledge in this field. Emphasis is placed on a comparison between experiment and theory. It is concluded that there are several gross properties which can be understood in terms of macroscopic models in a satisfactory way. Many microscopic aspects are still unexplored. (W.D.M.)

39790 THE MELTING OF ASTEROIDAL-SIZED BODIES BY UNIPOLAR DYNAMO INDUCTION FROM A PRIMORDIAL T TAURI SUN. Sonett, C. P. (Ames Research Center, Moffett Field, Calif.); Colburn, D. S.; Schwartz, K.; Keil, K. Astrophys. Space Sci.; 7: 446-88 (Jun 1970).

The heating of asteroidal parent bodies by electrical induction during early solar evolution and prior to positioning of the Sun onto the main sequence is examined. Under the conditions assumed, which include a high initial solar spin rate, interplanetary electric fields of the order 1 V/m would have existed in frames of reference comoving with the planets, leading to electrical heating from joule losses in the asteroidal interiors. The mechanism additionally requires the high plasma efflux characteristic of T Tauri objects and the presence of a circumstellar obscuration of the type commonly associated with early stellar objects. The proper combination of circumstellar obscuration, solar spin, solar-wind flow, and starting planetary temperatures is shown to lead to asteroidal heating competitive with that found for a class of fossil radioactive species. The time dependence of the solar spin and plasma flow are shaped so as to be consistent with current views on the evolution of T Tauri objects and of the spindown of stars. Calculations also include cases of joint heating by fossil radionuclides and electrical induction, and show a complicated relationship due to the intrinsic nonlinearity of the electrical heating mechanism. Implications regarding the pre-main sequence dynamics of the Sun are contained in the hypothesis of electrical heating if the contribution from radionuclides and gravitational accretion can be shown to be insufficient to account for the heating episode. Finally, some consequences of the mechanism applied to planets in the presence of an intense solar wind are considered. (auth)

39791 SOOBSHCHENIE SHEMAKHINSKOI ASTROFIZICHESKOI OBSERVATORII. VYPUSK 4. (Reports of the Shemakhinskoi Astrophysical Observatory. Number 4). Sultanov, G. F. (ed.). Baku; Izdatel'stvo Elm (1969). 99p.

Seven articles are included on data obtained by the Shemakhinskii Astrophysical Observatory. The results of the spectrophotometric studies of the high-power solar burst with overexcitation of the upper energy levels of hydrogen atoms observed May 13, 1960 are discussed in the first two articles. Determination of spectral classes and luminosity of eclipsing binary stars, changes in RW Aur spectra, and the influence of atmospheric interferences during studies of granulation are discussed in the next three articles. Outlines of weak Fraunhofer lines and the weak chromospheric burst on June 14, 1964 are covered in the last two articles. (R.V.J.)

39792 INFLUENCE OF INHOMOGENEITIES IN SOLAR-WIND VELOCITY ON THE STRUCTURE OF THE INTERPLANETARY MAGNETIC FIELD. Alekseev, I. I.; Kropotkin, A. P.; Shister, A. R. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 862-3(1969).

Translated from Geomagn. Aeron.; 9: 1067-8(1969).

The relationship between a possible large-scale magnetic field inhomogeneity and the anisotropy of solar-wind velocities is examined. Data on the structure of the solar wind at the orbit of the earth show significant anisotropy of the radial velocity of the plasma. Large-scale inhomogeneities of solar-wind velocity may lead to a significant reconstruction of the interplanetary field. (J.C.W.)

39793 PROPAGATION OF 1.5-MeV PROTONS GENERATED DURING SOLAR FLARES. Vernov, S. N.; Gorchakov, E. V.; Timofeev, G. A. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 775-9(1969).

Translated from Geomagn. Aeron.; 9: 961-7(1969).

The motion in the radial magnetic field of the Sun of protons generated by a solar flare is analyzed. Interaction with inhomogeneities of the interplanetary field is given in terms of the mean free path of protons between inhomogeneities and the average angle of scatter. The problem is analyzed by the Monte-Carlo method. The conditions of applicability of the diffusion theory to the problem of the propagation of solar protons are obtained on the assumption that the transport mean free path is constant. The results of computations of a proton flare at the orbit of the earth are compared with experimental data. (auth)

39794 MEASUREMENT OF SOLAR PROTONS ON MOLNIYA 1 MAY 25, 1967. Vernov, S. N.; Senchuro, I. N.; Tel'tsov, M. V.; Shavrin, P. I. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 780-2(1969).

Translated from Geomagn. Aeron.; 9: 968-71(1969).

Fluxes of ~500 cm^{-2} sec^{-1} solar protons with an energy E_p > 25 MeV were recorded May 25, 1967, by the radiometric equipment of Molniya 1. A maximum flux of ~5×10^5 cm^{-2} sec^{-1} electrons with an energy E_e > 1.2 MeV was recorded at 00h 40m UT on L ≈ 3.7. (auth)

Galaxies

39795 ROLE OF THE MAGNETIC FIELD IN A WAVE THEORY OF THE SPIRAL STRUCTURE OF GALAXIES. Marochnik, L. S.; Ptitsina, N. G. (Astrophysical Inst., Dushanbe, USSR). Astrophys. Space Sci.; 7: 437-45 (Jun 1970).

The spiral waves in a model galaxy consisting of the differentially rotating interstellar gas and Population I are considered. The instability of spiral waves in the presence of differential rotation and magnetic field is found. This instability may lead as well as the Landau instability found by Marochnik and Suchkov (1968, 1969) to the formation of an observable spiral pattern in a short time. It may play a definitive role in the spiral structure formation in galaxies with weak Population II. (auth)

39796 SUPERNOVAE IN A RANDOM SAMPLE OF GALAXIES. Chai, Check-Sen; van den Bergh, Sidney (Univ. of Toronto, Richmond Hill, Ont.). Astron. J.; 75: 672-3(Aug 1970).

A total of 3484 galaxies with diameters larger than 16 arc sec were searched for supernovae on overlapping portions of the glass copies of the Palomar Sky Survey. Six new supernovae were found. All of these new supernovae are located in late-type galaxies. The present data indicate that an "average" galaxy produces between four and ten supernovae per 1000 yr. (auth)

39797 SELF-CONSISTENT MODELS OF ELLIPTICAL GALAXIES. Prendergast, Kevin H. (Columbia Univ., New York); Tomer, Eugene. Astron. J.; 75: 674-9(Aug 1970).

Rotating, stationary models of elliptical galaxies were constructed using a Maxwellian distribution function modified by an energy cutoff. The Liouville equation and a nonlinear Poisson equation were solved simultaneously by an uncommon technique. The computed models are bounded and have many of the standard observed features. Comparison was made with NGC 3379. (auth)

39798 NUMERICAL INVESTIGATION OF POSSIBLE ORIGINS OF MOVING GROUPS. Innanen, K. A.; House, F. C. (York Univ., Toronto). Astron. J.: 75: 680-6(Aug 1970).

The galactic orbits of several families of stars, each of 40 stars, were computed in the mass model of Innanen (1966) for a time of 5.0×10^9 yr. The members of each family have the same energy and angular momentum. The 40 stars in each family were initially set flying apart near the Sun. Their subsequent positions were compared as a function of time to determine whether the stars came to within 2 kpc of each other. In all cases, close approaches of short duration were found after every complete revolution around the Galaxy. For a group of stars whose initial motions are at a high inclination to the galactic plane, close approaches of less than 250 pc were recorded, with the stars traveling in the same direction. The stars were found to lie on smooth curves like beads on a string which change in a consistent manner during each revolution around the Galaxy. This gives the possibility of the precise prediction of orbital behavior of stars of this class. A further family of orbits was investigated by considering stars escaping from a hypothetical globular cluster. No coalescences were found except for a slight tendency to congregate near their perigalactica. (auth)

39799 STUDY OF ABSORPTION AND REDDENING USING ABSOLUTE MAGNITUDES AND COLORS OF GALAXIES. Peterson, Bruce A. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astron. J.; 75: 695-702(Aug 1970).

Redshifts, V magnitudes, and V−r colors are given for the brightest galaxy in each of 48 clusters and seven groups of galaxies. Absolute magnitudes and colors are calculated for each cluster, and the latitude dependence of the absolute magnitudes and colors is attributed to galactic absorption. The values found for the color excess and absorption at the galactic pole are $E_{V-r} = 0.017 \pm 0.005$ and $A_V = 0.045 \pm 0.049$. Consideration of possible selection effects indicates that these values are 0.75 of the true values; the resulting corrected values are $E_{V-r} = 0.023 \pm 0.007$ and A_V 0.06 ± 0.07. If the Whitford absorption curve is valid this reddening corresponds to $E_{B-V} = 0.027 \pm 0.008$. (auth)

39800 REDSHIFT OF NGC 4569. Rodgers, A. W.; Freeman, K. C. (Australian National Univ., Canberra). Astrophys. J.; 161: L109-11(Aug 1970).

The systemic velocity of the spiral galaxy NGC 4569 in the Virgo cluster is about −300 km sec^{-1}. The velocities of the nucleus and the disk do not differ significantly. The difference of 1300 km sec^{-1} found by Weedman results from an error in the disk velocity given by Humason, Mayall, and Sandage. (auth)

39801 HIGH-REDSHIFT SEYFERT NUCLEUS IN THE ARMS OF A SPIRAL GALAXY. Weedman, Daniel W. (Univ. of Texas, Austin). Astrophys. J.; 161: L113-14(Aug 1970).

Object number 205 in Markarian's list of objects with strong ultraviolet continua appears within the spiral arms of the relatively nearby galaxy NGC 4319. Markarian 205 is observed to have a spectrum like the nuclei of Seyfert galaxies and a redshift 10 times greater than would be expected at the estimated distance of NGC 4319. (auth)

39802 ROCKET OBSERVATION OF INTERSTELLAR MOLECULAR HYDROGEN. Carruthers, George R. (Naval Research Lab., Washington, D. C.). Astrophys. J.; 161 L81-5 (Aug 1970).

The Lyman resonance-absorption bands of interstellar molecular hydrogen were observed in the far-ultraviolet spectrum of the star ξ Persei. The column density of H_2 is estimated to be about 1.3×10^{19} cm^{-2}. The column density of interstellar atomic hydrogen, determined from the Lα absorption line in the same spectrum is about 4.2×10^{20} cm^{-2}. Hence, in this line of sight, where visual total extinction by dust is about 1 mag, nearly half of the total hydrogen may be in molecular form. This is in agreement with theoretical predictions. (auth)

Cosmology

39803 (CPD-167) A NEW MODEL OF A SYMMETRIC UNIVERSE BASED ON INFORMATION THEORETIC CONCEPTS, WHICH CAN BE TESTED USING LASER TECHNIQUES. Werner, Alma; Hughes, J. L. (Weapons Research Establishment, Salisbury (Australia)). Oct 1969. 22p. Dep. CFSTI (U. S. Sales Only).

A new model of the symmetric Universe based on information theoretic concepts is proposed. Using the minimal structural requirements for such a model, it is shown that the detection of self-focusing of the photon distribution within the prescribed laser focus volume will lead to the verification of this model in the laboratory. (Australia)

39804 COSMIC BACKGROUND RADIATION AND ITS INTERACTIONS WITH COSMIC MATTER. Field, G. B. (Univ. of California, Berkeley). Riv. Nuovo Cim.; 1: Special No., 87-109 (1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

Topics discussed include molecular excitation by background radiation, interpretation of the black-body background radiation, cosmic nucleosynthesis, and recent effects of background radiation. (W.D.M.)

39805 RECENT RENAISSANCE OF OBSERVATIONAL COSMOLOGY. Sciama, D. W. (Cambridge Univ., Eng.). Riv. Nuovo Cim.; 1: Special No., 371-90(1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

A very brief review is given on observational cosmology from Einstein's inaugural paper on relativistic cosmology to 1965 when the dual discoveries of large redshifted objects and cosmic blackbody radiation were made. These two discoveries are discussed in detail in terms of radio source counts, quasar counts, intergalactic medium, and background microwaves. (W.D.M.)

39806 SPATIALLY HOMOGENEOUS ANISOTROPIC COSMOLOGICAL MODELS CONTAINING RELATIVISTIC FLUID AND MAGNETIC FIELD. Vajk, J. Peter; Eltgroth, Peter G. (Univ. of California, Livermore). J. Math. Phys. (N. Y.); 11: 2212-22(Jul 1970).

Spatially homogeneous, axially symmetric universes containing either an ideal fluid (with a γ-law equation of state) or a uniform magnetic field parallel to the symmetry axis or both are reviewed. In many cases, the field equations may be solved by the technique (described in detail) of replacing the cosmic time by a suitably chosen timelike parameter. Systematically all known exact solutions for such universes are derived. (auth)

39807 ANALYSIS OF THE REDSHIFT–APPARENT MAGNITUDE RELATION FOR 147 QUASI-STELLAR OBJECTS. Zotov, N. V.; Davidson, W. (Otago Univ., N. Z.). Aust. J. Phys.; 23: 351-62(Jun 1970).

Optical data for 147 quasi-stellar objects are analyzed to obtain an estimate of q_0, the present value of the deceleration parameter of the Universe. The group evolution of power of the observable quasi-stellar objects is determined as a function of epoch. Consideration is given to the possibility of a selection effect in the observations of the objects at large distances. Evidence is presented to show that any such selection effect does not restrict our view of the group evolution of the brightest objects as the redshift increases. It is concluded that q_0 most probably lies in the range $0 \leq q_0 \leq 0.18$, the best value for the actual sample being 0.005. This implies (for zero cosmological constant) that the expansion of the Universe is hyperbolic and nearly uniform in time. Even for the upper limit of q_0 the present density of matter would not exceed 3.83×10^{-30} g cm^{-3}. (Australia)

Planetary Phenomena

39808 DAYTIME UPPER IONOSPHERE OF VENUS. Whitten, R. C. (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res.; 75: 3707-14(1 Jul 1970).

The structure of the upper ionosphere of Venus as observed by Mariner 5 is analyzed from the standpoint of ionization sources and sinks, of ambipolar diffusion, and of model atmospheres proposed by other investigators. It is concluded that the profiles of molecular hydrogen and atomic oxygen that have been proposed to account for the observations of scattered solar Lyman-α radiation cannot be used to explain the upper ionosphere. Although the observed profiles of atomic hydrogen and deuterium may be adequate for explaining the topside ionosphere, the situation is doubtful. A better explanation is that the upper atmosphere contains a significant amount of helium (~3 to 5×10^7 cm^{-3}) at an altitude of 200 km. (auth)

Atomic and Molecular Physics

Refer also to abstract 39737.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 39383, 40224, and 40517.

39809 (ORNL-4446, pp 163-76) THEORETICAL RADIATION PHYSICS. Neufeld, Jacob; Ritchie, R. H.; Anderson, V. E.; (and others) (Oak Ridge National Lab., Tenn.).

ALUMINUM — stopping power for muons and protons at extreme relativistic energies, calculations
ELECTRON GAS — plasmon excitation in, mean free path for double
ELECTRONS — scattering by helium, matrix for elastic, (T)
— reactions with metal surfaces, photon emission by plasmons excited in, (T)
HELIUM — electron elastic scattering by, matrix for, (T)
HYDROGEN — positron scattering by atomic, variational calculations of phase shifts of
LINEAR ENERGY TRANSFER — spectra unfolding from pulse-height measurements, method for
MESONS (μ) — stopping power in aluminum at extreme relativistic energies, calculations
METALS — photon emission by surface plasmons in electron-bombarded, theory
PHOTONS — emission by surface plasmons in electron-bombarded metals, theory
PLASMA, SOLID-STATE — photon emission by surface plasmons in electron-bombarded metals, (T)
— reflectivity decrease of metallic surface due to surface plasmon effect, (T)
POSITRONS — scattering by hydrogen, variational calculations of phase shifts of
PROTONS — stopping power in aluminum at extreme relativistic energies, calculations
— dose absorbed in soft-tissue slab at 400 MeV, calculation
SCATTERING — variational method for long-range interaction, (T)
SURFACES — reflectivity decrease due to plasmon effect, (T)
TISSUES — proton depth-dose absorbed at 400 MeV in, calculation (D.L.C.)

39810 EJECTION AND ELECTRONIC EXCITATION OF FOIL PARTICLES BY HEAVY-ION IMPACT. Stoner, John O. Jr. (Univ. of Arizona, Tucson); Radziemski, Leon J. Jr. J. Opt. Soc. Amer.; 60: 1108-10(Aug 1970).

Optical spectra of beryllium, carbon, and aluminum atoms and ions from particles ejected from foils by impact of uranium ions were observed. The ejected particles responsible for the spectra had energies of the order of 10 keV; neutral and singly ionized species were predominant. This method of producing spectra may be useful in the extension of standard beam–foil techniques and for spectrochemical analyses of microgram quantities of certain materials. (auth)

39811 DISSOCIATION CROSS SECTION FOR SLOW COLLIDING EXCITED MOLECULES. Dozorov, A. A.; Kudrin, L. P.; Novikov, V. M. Zh. Eksp. Teor. Fiz.; 58: 1955-8(Jun 1970). (In Russian).

The cross section for the process $(AB^*) + M^* \rightarrow A + B + M$ is calculated; here $(AB)^*$ and M^* are molecules in the excited electron states. The cross section can be expressed in terms of well-known effective cross sections for photodissociation of molecules; at thermal energies it is of the order of 10^{-14} cm^2. (auth)

39812 EXCITATION OF THE Lα LINE DURING STRIPPING OF FAST NEGATIVE HYDROGEN IONS IN INERT GASES. Orbeli, A. L.; Andreev, E. P.; Ankudinov, V. A.; Dukel'skii, V. M. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 58: 1938-42(Jun 1970). (In Russian).

The intensity of the Lyman-α line emitted in collisions between fast hydrogen negative ions (5 to 40 keV) and He, Ne, Ar, Kr, and Xe atoms is measured. The cross sections for formation of hydrogen atoms in the 2s and 2p states and also the total cross sections for excitation of the n = 2 level are determined. In the energy range investigated the cross section $\sigma(2p)$, $\sigma(2s)$, and $\sigma(n = 2)$ are of the order of 10^{-16} cm^2 and $\sigma(2p) > \sigma(2s)$. In all gases investigated (with the exception of He) the cross sections $\sigma(2s)$, $\sigma(2p)$, and $\sigma(n = 2)$ weakly depend on the H^- ion energy. For Xe, minima are observed on the cross section curves $\sigma(2s)$, $\sigma(2p)$, and $\sigma(n = 2)$ at energies between 12 and 30 keV. A possible mechanism of production of excited hydrogen atoms in stripping of negative hydrogen ions as a result of removal of the "inner" electron from the H^- ion is discussed. (auth)

39813 RANGE DISTRIBUTION OF 4- TO 24-MeV ELECTRONS. Tabata, Tatsuo; Ito, Rinsuke; Okabe, Shigeru; Fujita, Yoshiaki (Kyoto Univ.). Annu. Rep. Radiat. Center Osaka Prefect.; 10: 34-41(1969).

Experimental data are presented of the range distribution of electrons in the absorbers of Be, Al, Cu, Ag, and Au. The measurement was made with a thin charge collector inserted in the absorber, and the energies of the investigated were 4.09, 7.79, 11.5, 14.9 and 23.5 MeV. The distributions observed were fitted with an empirical equation in which an expression for the transmission curve given by Mar is utilized in a slightly modified form. The most probable range R_m, the practical range R_p, the mean projected range R, the 1% range R_1, and the range straggling parameter ΔR were determined from the distributions. Two types of empirical equation for expressing the ratios of the range parameters to the theoretical mean range are compared, and the one originally proposed by Harder and Poschet (Phys. Lett., 24B: 519(1967)) was found to give a better fit for all the range parameters considered. (auth)

39814 INTERACTION OF ATOMIC OXYGEN WITH VARIOUS SURFACES. Riley, James A.; Giese, Clayton F. (Univ. of Minnesota, Minneapolis). J. Chem. Phys.; 53: 146-50(1 Jul 1970).

A pulsed atomic-oxygen beam is used to investigate the interaction of atomic oxygen with various surfaces at a pressure of 10^{-7} torr. The probability that an atom after striking a surface will return to the gas phase as an atom is measured for Pyrex, stainless steel, Teflon, gold, and titanium and is found to lie between 45 and 60% for all of these materials at room temperature. This reflection probability β is strongly temperature dependent for metals, dropping below 10% at 450°C, but less so for Pyrex, dropping only to 33% at the same temperature. The atoms that are not reflected apparently stick to the surfaces. In particular there is no evidence that at 10^{-7} torr they recombine to form O_2 or are emitted as parts of oxygen-containing molecules such as CO_2 or N_2O. Qualitative experiments indicate that recombination does take place at pressures near 1 torr. (auth)

39815 CHARGE STATES AND EXCITATION OF FAST HEAVY IONS PASSING THROUGH SOLIDS: A NEW MODEL FOR THE DENSITY EFFECT. Betz, Hans D.; Grodzins, Lee (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 25: 211-14(27 Jul 1970).

The theory of Bohr and Lindhard for electron capture and loss by heavy ions passing through solids is modified. It is concluded that the difference in the average equilibrium charge of fast ions traversing solids and dilute gases is mainly due to Auger processes that occur after the ions leave the solid. The charge states inside solids are (in disagreement with the deductions of Bohr and Lindhard) not much larger than those in gases. (auth)

39816 ZERO-FIELD QUANTUM BEATS SUBSEQUENT TO BEAM–FOIL EXCITATION. Andrae, H. J. (Univ. of Arizona, Tucson). Phys. Rev. Lett.; 25: 325-7(10 Aug 1970).

The creation of M_L alignment due to the foil excitation process is demonstrated with the observation of zero-field quantum beats in He $3^3P - 2^3S$ 3880-Å, hydrogen H_α, and hydrogen H_β emission. (auth)

39817 INFLUENCE OF INELASTIC SCATTERING ON ANOMALOUS ELECTRON TRANSMISSION IN GOLD FOILS. Hiller, G.; Just, T.; Niedrig, H. (Technical Univ., Berlin). Phys. Lett.; 32A: 262-3(27 Jul 1970).

In very thick gold foils the anomalous electron transmission was found to be covered by inelastic multiple scattering causing a reduction of the absorption coefficient and of its strong temperature dependence. (auth)

39818 ABSOLUTE DETECTION OF He(2^1S) AND He(2^3S) METASTABLE ATOMS. Dunning, F. B.; Smith, A. C. H. (University Coll., London). Phys. Lett.; 32A: 287-8(27 Jul 1970).

Secondary electron ejection coefficients were measured as 0.49 ± 0.09 for He(2^1S) and 0.67 ± 0.10 for He(2^3S) striking chemically cleaned gold. The singlet-to-triplet Penning ionization cross section ratio was evaluated as 1.1 (+0.4, −0.2) in argon. (auth)

39819 CROSS-BEAM NEUTRALIZER (17 Sep 1968) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1987).

3 drawings.

The cross-beam water-vapor neutralizer is used with 1- to 15-keV proton beams to reduce the amount of thermal gas that

effuses down the beam line by as much as a factor of 7. The neutralizer consists of a collimating array of fused-glass capillaries. The array is set into the side of a small tank and oriented normal to the beam axis. Water vapor is admitted into the tank through a leak valve. The vapor streams through the array, crosses the proton beam, and is pumped on a liquid-nitrogen-cooled surface. (For details see TID-4100 Suppl. 58) (See also 24: 10363) (F.S.)

39820 CONVOLUTION ANALYSIS OF ELECTRON IMPACT EXPERIMENTS. Cowperthwaite, Ronald L.; Myers, Howard (McDonnell Douglas Astronautics Co., St. Louis). J. Chem. Phys.; 53: 1077-82(1 Aug 1970).

Electron-impact experiments are analyzed from the standpoint of the influence of the electron-beam energy distribution on the measurements. A generalized electron energy distribution function is formulated. Special cases of this distribution function yield analytical representations of operational electron guns. The energy distribution of the gun is found to strongly affect the salient features of the cross section. A procedure is thence developed for unfolding the true cross section from impact measurements by removing the distortion of the electron beam. Comparisons with measured data are presented. (auth)

Atomic and Molecular Properties

Refer also to abstract 40078.

39821 (ORNL-4562) COMPREHENSIVE CALCULATION OF IONIZATION POTENTIALS AND BINDING ENERGIES FOR MULTIPLY-CHARGED IONS. Carlson, Thomas A.; Nestor, C. W. Jr.; Wasserman, Neil; McDowell, J. D. (Oak Ridge National Lab., Tenn.). Jul 1970. Contract W-7405-eng-26. 43p. Dep. CFSTI.

Ionization potentials were calculated for all the elements up to Z = 103 for all states of ionization. The calculations are based on a simple spherical shell model using eigenvalues and mean radii from Hartree–Fock solutions for neutral atoms. The average deviation of the calculated ionization potentials from experimental values was found to be within 5%. A simple method was developed for estimating the binding energies in all shells of a multiply charged ion from the calculated ionization potentials. (auth)

39822 GROUND STATES AND NORMAL ELECTRONIC CONFIGURATIONS OF CALIFORNIUM I AND II. Worden, Earl F. (Univ. of California, Livermore) Conway, John G. J. Opt. Soc. Amer.; 60: 1144-5(Aug 1970).

The Cf spectrum was photographed from 2300 to 10500 Å with the ANL 9.15-m Paschen–Runge spectrograph. Zeeman-effect spectra at a field strength of 24,000 G were also photographed. From analysis of these spectra, the ground level of the neutral atom and the two lowest levels of the first ion (Cf II) were identified, and the normal electronic configurations were established. The configuration of the ground level of Cf I was found to be $5f^{10}7s^2$. The ground level of Cf II is $^6I_{\frac{1}{2}}$ and the second level is $^4I_{\frac{1}{2}}$ at 1180.54 cm^{-1}; these are the lowest levels of the configuration $5f^{10}7s$. (A.G.W.)

39823 MULTIPLE QUANTUM TRANSITIONS. Winter, J. M. (CEN de Saclay, Gif-sur-Yvette, France). Riv. Nuovo Cim.; 1: Special No., 506-14(1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

An atomic or molecular system having a spectrum of discrete levels is studied. A model for multiple transitions is described. Some examples are given. (M.O.W.)

39824 PROPERTIES OF AXICON SYSTEMS FOR COLLECTING FOIL-EXCITED ACCELERATOR BEAM SPECTRA. Stoner, J. O. Jr. (Univ. of Arizona, Tucson). Appl. Opt.; 9: 53-7(Jan 1970).

A particular kind of light-collecting system used for spectroscopy of light emitted by foil-excited accelerator beams is described. This system, built to test the possibility of obtaining narrow lines from such sources, has as its basic optical element an axicon, a conical reflector with its axis coincident with that of the accelerator beam. The properties of an axicon followed by a lens and aperture are discussed, and some criteria that are appropriate to the design of optical systems using such devices are considered. Experimentally, one finds that scattering of the accelerator beam by the foil contributes significantly to spectral linewidths. (auth)

39825 REVIEW OF THE THEORIES OF X-RAY SATELLITE LINES. Edwards, S. J. (City Polytechnic, Leicester, Eng.). Contemp. Phys.; 11: 195-200(Mar 1970).

A review has been made of the theories of the origin of x-ray satellite lines; the theories proposed since 1959 are dealt with in some detail. It seems certain that satellites are due to transitions in atoms which have an anomalous configuration of orbital electrons or are multiply ionized. The method of production of these configurations is the subject of all the theories. Recent results indicate that anomalous configurations and multiply ionized states can arise following a normal single ionization process. (auth) (UK)

39826 EFFECTIVE ATOMIC NUMBER OF ELEMENTS AND OF COMPLEX MEDIA FOR LOW-ENERGY GAMMA RADIATION. Leman, E. P. At. Energ. (USSR); 27: 474-5(Nov 1969). (In Russian).

The effective atomic number, Z_{eff}, of a complex medium, needed for studying the interaction of γ radiation with various materials, cannot be calculated by using the usual formulas if the K level of one of the constituent elements of the material has a higher energy than the γ radiation. Solution of this problem involves finding an element in the periodic system that possesses photoabsorption coefficients above the K level of the same value as the corresponding coefficients of another element between the K and L levels. In that case, the atomic number of the first element is the effective atomic number of the second one. The results indicated that $Z_{eff} = 0.3112Z^{1.13}$. The calculation was illustrated for the case Zn, Sn, and Hg, with atomic numbers of 30, 50, and 80, respectively. (TTT)

39827 HYPERFINE STRUCTURE INVESTIGATIONS OF EXCITED STATES OF Lu I BY MEANS OF THE LEVEL-CROSSING METHOD. Goebel, L. H. (Technische Univ., Berlin). Z. Naturforsch.; 25a: 611-20(May 1970). (In German).

The magnetic dipole and the electric quadrupole interaction constants in the excited electronic states $5d6s6p(^1D)^2D_{\frac{5}{2}}$ and $5d6s6p(^1D)^2F_{\frac{5}{2}}$ of ^{175}Lu I in natural isotopic abundance were investigated. The measurement was performed by resonance scattering of light with wavelengths $\lambda = 4518.57$ Å and $\lambda = 3567.84$ Å on a lutetium atomic beam. The following hyperfine structure constants were obtained: $B/A\{(^1D)^2D_{\frac{5}{2}}\} = +0.34704(80)$; $A\{(^1D)^2D_{\frac{5}{2}}\} = -1313.34(50)$ gj/0.80 MHz; $B\{(^1D)^2D_{\frac{5}{2}}\} = -455.8(1.2)$ gj/0.80 MHz; $B/A\{(^1D)^2F_{\frac{5}{2}}\} = +9.7883(37)$; $A\{(^1D)^2F_{\frac{5}{2}}\} = +351.864(56)$ gj MHz; $B\{(^1D)^2F_{\frac{5}{2}}\} = +3444.2(1.9)$ gj MHz. The signs of the interaction constants were determined by examinations of these lines in a Fabry–Perot interferometer. The lifetimes of the investigated states were found as follows: $\tau\{(^1D)^2D_{\frac{5}{2}}\} = (4.9 \pm 0.1) \times 10^{-8}$ sec; $\tau\{(^1D)^2F_{\frac{5}{2}}\} = (1.2 \pm 0.1) + 10^{-8}$ sec. from these the oscillator strengths were deduced: f(3567.8 Å) = $(1,7 \pm 0.2) \times 10^{-1}$; f(3841.2 Å) = $(5.6 \pm 0.8) \times 10^{-2}$; f(4518.6 Å) = $(6.3 \pm 0.1) \times 10^{-2}$; f(4967.5 Å) < 3×10^{-4}. (auth)

39828 MIT WAVELENGTH TABLES. SECOND EDITION. Harrison, George R. Cambridge, Mass.; Massachusetts Institute of Technology Press (1969). 464p. $25.00.

The main tables in this volume contain more than 100,000 entries giving the wavelength, the intensity in arc, spark, or discharge tube, the stage of ionization of the parent atom when the line has been classified in a term array, and the wavelength authority, for each of the most important known spectrum lines emitted between 10,000 and 2,000 Å by atoms in the first two stages of ionization. Entries are arranged in order to decreasing wavelengths. This revision consists of photographs of the pages of the 1939 edition with corrections listed for every entry known to need improvement. (A.G.W.)

39829 ATTENUATION OF 5.9-keV PHOTONS BY HELIUM AND HYDROGEN. McCrary, J. H. (Edgerton, Germeshausen, and Grier, Inc., Las Vegas, Nev.); Looney, L. D.; Atwater, H. F. J. Appl. Phys.; 41: 3570-2(Aug 1970).

The narrow-beam mass-attenuation coefficients of helium and hydrogen were measured at 5.895 keV. A K_β-filtered ^{55}Fe source of Mn x rays, a set of collimators, and a low-energy sodium iodide counter were used with a high-pressure gas chamber. Photon intensities were measured with and without gas in the chamber. The measured coefficients are 0.416 ± 0.017 cm^2/g for He and 0.400 ± 0.016 cm^2/g for H_2. These numbers are compared with theoretical predictions of this parameter. (auth)

39830 GROUND-STATE ENERGY OF THREE ATOMIC HELIUM MOLECULES. Stenschke, Herbert (Battelle Memorial Inst., Columbus, Ohio). J. Chem. Phys.; 53: 466(1 Jul 1970).

A lower bound for the ground-state energy of three atoms interacting pair-wise via a Lennard–Jones potential was calculated. In this approximation it was found that the existence of a molecule formed by three ^{3}He atoms can be ruled out, but three ^{4}He atoms may form a bound state. The ground-state energy obtained for three ^{4}He atoms is $-0.17°K < E^4He^0 < -0.08°K$. (A.G.W.)

39831 COMPARATIVE STUDY OF ELLIPSOIDAL GAUSSIANS: H_2 AND H_2^{++}. Katriel, J.; Adam, G. (Nuclear Research Center, Beer-Sheva, Israel). J. Chem. Phys.; 53: 302-5(1 Jul 1970).

A series of calculations is carried out for H_2 and HeH^{2+} using ellipsoidal Gaussian wave functions. Comparison to spherical Gaussians shows that the additional variational freedom results in lower energy expectation values. (auth)

39832 UPPER AND LOWER BOUNDS FOR THE GROUND STATE OF H_3^{2+} BY THE BOUNDARY CONDITION METHOD. Rosenthal, C. M.; Wilson, E. Bright (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 53: 388-91(1 Jul 1970).

Upper and lower bounds for the ground-state energy of linear symmetric H_3^{2+} are calculated at several nuclear separations as an example of the boundary condition method; it is verified that this form is not stable with respect to dissociation. (auth)

39833 CALCULATION OF THE He–H INTERACTION ENERGY. Fischer, C. R. (Queen's Coll., Flushing, N. Y.); Kemmey, P. J. J. Chem. Phys.; 53: 50-2(1 Jul 1970).

The He–H interaction energy was calculated by an SCF open-shell procedure due to Roothaan. Results obtained are in good agreement with the interaction deduced from atomic-beam measurements of Amdur and Mason. The present calculation yielded lower values for the short-range potential than other comparable theoretical calculations. (auth)

39834 HANDBOOK:OF THE ATOMIC ELEMENTS. Williams, R. A. New York; Philosophical Library, Inc. (1970). 125p. $6.00.

This reference book was specifically designed to contain the most important, or at least the most often used, measurements and parameters pertinent to the atomic elements and their classification in periodic categories. The elements, ranging from Hydrogen at Atomic Number 1, through Lawrencium at Atomic Number 103, are arranged in alphabetical order so that any element can be located in less time than it takes to look up a word in the dictonary. The information on each of the elements is based on Carbon-12 and values released by the International Union of Pure and Applied Chemistry. The physical values are grouped for easy reference and include data in the following categories: the name of the element and its atomic symbol; principal quantum number (n period); atomic number; atomic weight; x-ray notation; group; category; state; origin; the number of protons and electrons; valence (s); subshell filling; the atomic, covalent and ionic radii; ground state electron configuration; valence electrons; core member; and acid-base properties. Also included are the atomic volume; density; type of crystal structure, electronegativity and electrical conductance; first ionization energy; ionization potential; heat of vaporization; specific heat; thermal conductance; boiling point and melting point. Radioactive isotopes for each element are listed, as well as their half-lives accompanied by the emission particle. All of the values given are provided with units and dimensional analysis. Numerous helpful tables and a copy of the periodic classification of the elements (chart) are included. (auth)

39835 OBSERVATION OF THE LAMB SHIFT IN A FAST HYDROGEN BEAM. Fabjan, C. W.; Pipkin, F. M. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett.; 25: 421-4(17 Aug 1970).

A new technique of observing the Lamb shift, which combines beam–foil and radiofrequency spectroscopy techniques, is described. Measurements are made at zero magnetic field by sweeping the radiofrequency field. A radiofrequency hyperfine state selector is used to reduce the effect of overlapping lines. (auth)

39836 ATOMIC SPECTRA. Kuhn, H. G. New York; Academic Press Inc. (1969). 488p. $14.50.

The subject of atomic spectra is treated in an introductory manner, yet more thoroughly than in general textbooks on modern physics. The approach is physical rather than mathematical. The correspondence between classical and quantum physics is stressed. Section headings are as follows: theoretical methods, simple spectra, complex spectra, periodic table and x-ray spectra, hyperfine structure and isotope shift, width and shape of spectral lines. A bibliography for each section is included. (A.G.W.)

39837 ENERGY OF INTERACTION BETWEEN TWO HYDROGEN ATOMS USING GAUSSIAN-TYPE FUNCTIONS. Brenner, Stephen L.; Konowalow, Daniel D. (State Univ. of New York, Binghamton). J. Chem. Phys.; 53: 1301-2(1 Aug 1970).

An error is pointed out in the list of integrals used by Kim and Hirschfelder (KH) in an earlier article (J. Chem. Phys., 47: 1005 (1967)) on use of Gaussian-type wave functions in calculation of the interaction energy of two ground-state H atoms. Differences between the KH results and results of the present recalculations are summarized, but the original KH conclusion that use of Gaussian-type wave functions for interaction-energy calculations was not promising remains unchanged. (A.G.W.)

39838 EQUILIBRIUM BOND LENGTH IN H_3^+. Schaad, L. J.; Hicks, W. V. (Vanderbilt Univ., Nashville). J. Chem. Phys.; 53: 851-2(15 Jul 1970).

It is shown that the equilibrium internuclear distance in H_3^+ is definitely less than 2 and is approximately 1.9972. (A.G.W.)

39839 CALCULATION OF SPIN–ORBIT COUPLING CONSTANTS AND OTHER RADIAL PARAMETERS FOR THE ACTINIDE IONS USING RELATIVISTIC WAVE FUNCTIONS. Lewis, W. Burton; Mann, Joseph B.; Liberman, David A.; Cromer, Don T. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys.; 53: 809-20(15 Jul 1970).

Relativistic self-consistent Dirac–Slater and Dirac–Fock wave functions were used to evaluate the spin–orbit coupling constant and matrix elements of r^n for most of the actinide ions and neutral atoms. Empirical corrections for the Dirac–Slater ζ_{sf} constants based on experimental results are suggested, which enable one to predict free-ion values more accurately. Values of ζ_{sf} from crystal and solution spectra show reductions from these estimates, which are independent of atomic number Z but vary roughly according to ionic charge and ligand electronegativity. It is shown that $\langle r^{-3} \rangle$ parameters from atomic beam measurements on Sm, Eu, Pu, and Am can be accounted for fairly well with relativistic Dirac–Slater wave functions and intermediate coupling eigenvectors; configuration interaction, core polarization, and other contributions to hyperfine coupling are neglected. Similar calculations with hyperfine coupling constants from crystal EPR spectra are less consistently satisfactory. (auth)

39840 APPLICATION OF MANY-BODY PERTURBATION THEORY TO THE HYDROGEN MOLECULE. Schulman, Jerome M.; Kaufman, D. Neal (Polytechnic Inst. of Brooklyn). J. Chem. Phys.; 53: 477-84(15 Jul 1970).

The hydrogen molecule total energy, polarizabilities, and electron-coupled nuclear spin–spin Fermi interaction are studied by many-body perturbation theory. Two potentials, the Hartree and Hartree–Fock, are considered. Through second order the energies are within several kilocalories per mole of the accurate nonrelativistic values. The Hartree–Fock expansion is reasonably accurate through first order for polarizabilities and gives very good agreement with experiment if a rather simple geometric approximation is used. For the spin–spin coupling constant, good agreement with experiment is obtained using the Hartree potential and considering some second- and higher-order diagrams. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

39841 MUON SPIN PRECESSION IN MESIC MOLECULES. Samoilov, V. M. (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz.; 58: 2202-9(Jun 1970). (In Russian).

Nuclear spin interaction in a diatomic molecule consisting of muonium and an atom with a nuclear spin of $\frac{1}{2}$ is considered when a magnetic field H is directed perpendicular to the quantization axis. Two cases are considered, that of a "fixed" and that of a "rotating" molecule. The exact values of the terms and the time dependence of the muon polarization vector are obtained for the "rotating" molecule. Approximate solutions for an arbitrary orientation (which go over to the exact ones in absence of a field) and exact solutions for some selected orientations of the molecule are obtained for a "fixed" molecule. Numerical estimates of possible precession frequencies for the MuH molecules are presented. (auth)

39842 POSITRON ANNIHILATION IN QUARTZ IRRADIATED BY FAST NEUTRONS. Bartenev, G. M.; Tsyganov, A. D.; Varisov, A. Z.; Prokop'ev, E. P. (Leningrad State Pedagogical Inst.). Zh. Eksp. Teor. Fiz.; 58: 1904-10(Jun 1970). (In Russian).

The effect of fast-neutron irradiation on the angular distribution of annihilation γ-quantum pairs in crystal and fused quartz is investigated. It is found that the half-width of the correlation curves corresponds to the variation of the quartz density. From an analysis of various positron states in quartz preceding annihilation and on the basis of the experimental data, it is concluded that variation of the half-width is due to the appearance in the correlation curves of a narrow component whose intensity depends on the radiation dose. The narrow component is due to annihilation decay of para-positronium atoms produced in irradiated quartz. (auth)

39843 EFFECT OF THE CRYSTAL LATTICE OF SILICON ON THE HYPERFINE SPLITTING ENERGY OF MUONIUM. Andrianov, D. G.; Minaichev, E. V.; Myasishcheva, G. G.; Obukhov, Yu. V.; Roganov, V. S.; Savel'ev, G. I.; Firsov, V. G.; Fistul, V. I. Zh. Eksp. Teor. Fiz.; 58: 1896-8(Jun 1970). (In Russian).

The dependence of μe decay polarization on longitudinal magnetic field strength is measured in silicon single crystals. The hyperfine splitting energy of the muonium atom in the crystal lattice differs from the vacuum value and corresponds to a muonium size r = (0.719 ± 0.016) Å. (auth)

39844 POSITRON ANNIHILATION IN SYNTHETIC ZEOLITES 4A AND 13X. Perkal, M. B.; Walters, W. B. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys.; 53: 190-8(1 Jul 1970).

The rates of positron annihilation in synthetic zeolites 4A and 13X were measured under a variety of conditions. For zeolites 4A and 13X, respectively, long lifetime values (τ_2 in nanoseconds) and intensities I_2 (listed in parentheses) were found as follows: hydrated, 2.26 ± 0.18 (20.5%) and 1.95 ± 0.20 (21.6%); evacuated, 3.76 ± 0.10 (25.4%) and 4.42 ± 0.25 (21.8%); filled with O_2, 3.34 ± 0.25 (4.2%) and 4.15 ± 0.35 (4.6%); filled with He, 2.90 ± 0.11 (23.8%) and 3.28 ± 0.12 (20.0%); filled with N_2, 2.97 ± 0.12 (23.7%) and 3.39 ± 0.10 (25.3%); filled with methane, 4.10 ± 0.06 (28.2%) and 3.78 ± 0.11 (24.8%). Very long components (τ_3) with lifetimes of 42.2 ± 11.2 nsec and 41.4 ± 4.0 nsec for 4A and 13X, respectively, were observed in evacuated zeolites. Because the cavity sizes are well known from x-ray diffraction studies, the slightly larger lifetime observed in 13X relative to 4A for evacuated zeolites is thought to reflect the larger free volume present in the 13X configuration. The reduced lifetimes observed with He or N_2 inclusion are postulated to result from reduced free volumes, whereas the reduced intensities observed with O_2 inclusion may result from low O_2 and positronium mobility coupled with nonuniform O_2 distribution. Values for the short-lifetime component (τ_1) were also observed and found to be relatively constant for each type of zeolite. (auth)

39845 TRAPPING OF POSITRONS AT VACANCIES IN METALS. Hodges, C. H. (Queen's Univ., Kingston, Ont.). Phys. Rev. Lett.; 25: 284-7(3 Aug 1970).

Measurements of the lifetime for positron annihilation in metals show a temperature dependence which has been ascribed to the trapping of positrons at vacancies. An explanation of this trapping process is presented in terms of an effective potential well, whose depth is the difference between the bottom of the positron energy band in the solid and the potential felt by the positron inside the vacancy. (auth)

39846 CRITICAL BEHAVIOR OF POSITRONS IN LOW-TEMPERATURE GASEOUS HELIUM. Canter, K. F.; Roellig, L. O. (Wayne State Univ., Detroit). Phys. Rev. Lett.; 25: 328-30(10 Aug 1970).

The time-decay spectra of positrons annihilating in helium gas from 4.6 to 30°K were obtained and it is found that the spectra exhibit a large variation with respect to a small change in temperature. Many-body effects are discussed in connection with the data. (auth)

39847 EXOTIC ATOMS. Burhop, E. H. S. (London Univ.). Contemp. Phys.; 11: 335-58(Jul 1970).

Electrically charged elementary particles may be incorporated into atoms and molecules. A negatively charged particle may replace an electron while a positively charged particle may capture an electron forming an entity having many properties similar to those of an H atom. These unusual types of atom or molecule have many applications including catalyzing nuclear fusion, probing both the charge and nuclear matter distribution in a nucleus, providing accurate methods of measurement of fundamental constants, and acting as tracing atoms for monitoring chemical reactions of atomic hydrogen. (auth) (UK)

39848 POSITRON ANNIHILATION IN DILUTE SOLID SOLUTIONS. Dekhtyar, I. Ya. (Inst. of Metal Physics, Kiev). Phys. Lett.; 32A: 246-7(27 Jul 1970).

The impurity effect on the form changing of the angular correlation curve for annihilation radiation is investigated. The annihilation mechanism in dilute solid solutions containing localized magnetic moments is related to positron capture by the perturbation centers. (auth)

39849 5g → 4f PIONIC TRANSITION IN ^{232}Th AND ^{238}U. Jenkins, D. A.; Powers, R. J. (Virginia Polytechnic Inst., Blacksburg). Phys. Rev., C; 1: 2050-3(Jun 1970).

Early measurements of pionic x-ray energies and widths in ^{232}Th and ^{238}U suggest the possibility of an anomalous effect for the interaction between high-Z nuclei and a pion in the 4f atomic state. The remeasured 5g → 4f x-ray energies and widths in these isotopes are compared with a calculation that considers the distortion of the nucleus. A small disagreement between theory and experiment persists, but it is probably due to uncertainties in the calculation of the strong-interaction effects. (auth)

Collision Phenomena

Refer also to abstract 39459.

39850 (LA-4403) RELATIVISTIC CALCULATION OF ANOMALOUS SCATTERING FACTORS FOR X RAYS. Cromer, Don T.; Liberman, David (Los Alamos Scientific Lab., N. Mex.). May 1970. Contract W-7405-eng-36. 163p. Dep. CFSTI.

Anomalous scattering factors, $\Delta f'$ and $\Delta f''$, were calculated relativistically for chromium, iron, copper, molybdenum, and silver Kα radiations for the atoms lithium through californium. Relativistic calculations of the photoelectric cross section were made, and, in contrast to previous calculations, the integral for the principal contribution to $\Delta f'$ was evaluated numerically without approximation to the form of the cross-section vs energy curve. Many of the results differ significantly from previous calculations. Where experimental values exist, agreement for $\Delta f'$ is improved. For the rare gases, except for xenon, agreement between $\Delta f'$ and experiment is also improved. Because of the more rigorous evaluation of $\Delta f'$ from cross-section information, it is presumed that the present $\Delta f'$ values are more accurate than those previously calculated. Calculated mass absorption coefficients for the elements are included as incidental information. A FORTRAN program for interpolating cross sections and computing the dispersion at other wavelengths is also given. (auth)

39851 (NYO-3829-51) EXACT SCREENED CALCULATIONS OF ATOMIC FIELD BREMSSTRAHLUNG. Tseng, H. K.; Pratt, R. H. (Pittsburgh Univ., Pa. Dept. of Physics). May 1970. Contract AT(30-1)-3829. 68p. Dep. CFSTI.

A discussion of relativistic bremsstrahlung cross sections is given for incident electron kinetic energies in the range 5 keV to 1 MeV, based on an exact numerical calculation in screened potentials. Comparisons are made with previous authors, extending the discussion of a preliminary note (Phys. Rev., A1: 528 (1970)), and with experiment. Exact point Coulomb and Born approximation results are contrasted. The present results show that the Born approximation significantly underestimates the bremsstrahlung cross sections in the energy region considered. Screening effects are somewhat larger than expected and when large are not well described by a form factor. (auth)

39852 (ORNL-4446, pp 197-205) ATOMIC AND MOLECULAR RADIATION PHYSICS. Christophorou, L. G.; Anderson, V. E.; Birks, J. B.; (and others) (Oak Ridge National Lab., Tenn.).

Work done during the period on the following projects is summarized: momentum transfer in scattering of slow electrons by polar molecules; energy losses of slow electrons in gases; electron attachment to p-benzoquinone and N_2O; geminate scavenging probabilities in cyclohexane; efficiencies of photosensitized ionization in argon–ethylene mixtures; lifetimes of excited fluorescing species in liquid benzene, toluene, and mesitylene; degradation spectra for 100-keV electrons in model systems; and total ionization produced in gases by complete absorption of alpha and beta particles. (A.G.W.)

39853 (ORNL-4446, pp 206-15) ELECTRON AND ION COLLISION PHYSICS. Compton, R. N.; Anderson, V. E.; Carter, Ada; (and others) (Oak Ridge National Lab., Tenn.).

Work during the period on the following is summarized: trapped-electron studies of electron-impact excitation of argon, helium, and xenon fluorides; electron attachment and dissociative electron attachment of NH_3, ND_3, C_6F_5Br, azulene-h_8, azulene-d_8, and various hexafluoride molecules; attachment rates of thermal electrons by SF_6 in different carrier gases; upper estimates of thermal-electron attachment rate by some halocarbons and TeF_6; and low-energy reactions of H^-, D^-, and O^- with molecules. (A.G.W.)

39854 THEORY OF FORMATION OF EXCITED HYDROGEN ATOMS IN COLLISIONS BETWEEN NEGATIVE HYDROGEN IONS AND NEUTRAL ATOMS. Drukarev, G. F. (Leningrad State Univ.). Zh. Eksp. Teor. Fiz.; 58: 2210-12(Jun 1970). (In Russian).

Collisions between a neutral hydrogen atom and negative hydrogen ion leading to removal of an electron from the negative ion and to the formation of an excited hydrogen atom are considered. It is shown that in a certain approximation the process may be considered as involving the ejection of a strongly bound electron

from the negative ion and subsequent adaptation of the remaining electron to the modified field. This concept implies that the energy dependence of the yield of hydrogen atoms excited in the s-state should be the same as for ionization of the hydrogen atom. (auth)

39855 ELECTRON COLLISIONS. Seaton, M. J. (University Coll., London). Riv. Nuovo Cim.; 1: Special No., 391–402 (1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

Work on electron–atom collisions is reviewed at length by Massey and Burhop (Electronic and Ionic Impact Phenomena, Vol. I, 2nd Ed., (Oxford, 1969)). This paper is restricted to a discussion of a few selected topics for which there have been recent advances, both in experimental and theoretical work. (auth)

39856 SCATTERING OF 50 keV-ELECTRONS BY LIQUID HELIUM. Keck, K. (Univ., Mainz). Z. Phys.; 236: 321–36 (1970). (In German).

The behavior of liquid helium in relation to electron scattering was investigated. Electrons of 50 keV were scattered by thin targets of liquid helium with temperatures between 1.34 and 2.15°K. The thickness of targets was chosen between 0.047 and 0.62 mm. The angular distribution and energy loss of the scattered electrons were measured in dependence on thickness of the layer and on temperature. The extrapolated range of electrons in liquid helium was determined. (auth)

39857 CLOSE COUPLING INFLUENCE ON THE THRESHOLD BEHAVIOR OF ELECTRON–ATOM EXCITATION CROSS SECTIONS. Gailitis, M. (Inst. of Physics, Riga). Teor. Mat. Fiz.; 3: 364–76(Jun 1970). (In Russian).

The threshold behavior of cross sections in the case of nondiagonal potential $\sim\alpha r^{-2}$ is considered. The deviations from Wigner's law and the behavior of cross sections for very large α are investigated. (auth)

39858 EFFECT OF NUCLEAR SYMMETRY IN ATOM–ATOM SCATTERING. Siska, P. E.; Parson, J. M.; Schafer, T. P.; Tully, F. P.; Wong, Y. C.; Lee, Y. T. (Univ. of Chicago). Phys. Rev. Lett.; 25: 271-2(3 Aug 1970).

A high-resolution measurement of the differential elastic-scattering cross section for the Ne–Ne system shows wide-angle oscillations consistent with the prediction for identical particles based on a Lennard-Jones (12, 6) potential derived from transport properties. (auth)

39859 PHOTODETACHMENT OF ELECTRONS FROM STABLE NEGATIVE IONS. Feldmann, D. (Univ., Hamburg). Z. Naturforsch.; 25a: 621-6(May 1970). (In German).

Photodetachment of electrons from some stable negative ions was measured. Cross sections of about 10^{-17} cm^2, and the following minimal detachment energies were found: H^-: 0.776 eV; C^-: < 0.5 eV; CH^-: 0.74 eV; C_2^-: 3.54 eV; C_2H^-: 3.73 eV; SO^-: 1.09 eV; SO_2^-: 1.0 eV. Accuracy was better than ± 0.05 eV. (auth)

39860 SPATIAL DISTRIBUTION OF THE FLUORESCENT RADIATION EMISSION CAUSED BY AN ELECTRON BEAM. Cohn, A.; Caledonia, G. (Avco Everett Research Lab., Everett, Mass.). J. Appl. Phys.; 41: 3767-75(Aug 1970).

The side-view intensity profiles of the N_2^+ (1–) (0, 0) radiation emission caused by an electron beam fired into N_2 gas were measured. By Abel inversion the three-dimensional radiation emission distribution was computed from these profiles. Measurements were made for beam energies of 2.0 to 5.0 keV and gas density of 0.60 to 2.8 torr. With proper normalization, the spatial intensity distribution shows no significant variation with voltage. The close relationship between the radiation, energy loss, and ionization deposition distributions is discussed. Integrals of the data reasonably agree with the theory of Spencer and Fano and the data of Grün. (auth)

39861 MULTIPLE TRANSITION PROBABILITIES IN THE SEMICLASSICAL APPROXIMATION. Roberts, R. E. (Indiana Univ., Bloomington); Johnson, B. R. J. Chem. Phys.; 53: 463–4 (1 Jul 1970).

In the semiclassical approximation for multiple quantum transition probabilities in vibrationally inelastic collisions, the internal molecular motion is treated quantally; the relative translational motion is determined classically. Results of exact calculations for the model problem of a collinear collision of an atom with a harmonic oscillator are tabulated. Excellent agreement of these results with exact calculations clearly demonstrates the validity of the method. (A.G.W.)

39862 ELECTRON DETACHMENT IN COLLISIONS OF LOW-ENERGY O^- IONS WITH N_2. Compton, R. N.; Bailey, T. L. (Univ. of Florida, Gainesville). J. Chem. Phys.; 53: 454–6(1 Jul 1970).

Total cross sections for the production of free electrons in collisions of O^- ions with N_2 molecules were measured for incident ion energies from 3.5 to 350 eV. The rf electron filter technique was used to separate currents of detached electrons and slow product negative ions. The data show that the detachment cross section decreases rapidly as the primary ion energy decreases below 100 eV. It is concluded that the major contributions to the observed cross sections arise from $O^- + N_2 = O + N_2 + e^-$. (A.G.W.)

39863 STATISTICAL ANALYSIS OF TRANSITION PROBABILITY MATRICES IN THE STRONG COUPLED ROTATIONAL EXCITATION PROBLEM. Lester, William A. Jr. (IBM Research Lab., San Jose, Calif.); Bernstein, R. B. J. Chem. Phys.; 53: 11–20(1 Jul 1970).

Scattering matrices accurately computed via close-coupling techniques are analyzed and discussed as a function of critical parameters of an atom–diatomic molecule scattering system. The usefulness of the t test for delineating the region of strong coupling and ascertaining the range over which statistical approximations may be appropriate is demonstrated. (auth)

39864 EXCITATION OF ARGON IONS BY ELECTRON–ATOM COLLISIONS. Feitsan, P. V.; Povch, M. M. Opt. Spectrosc. (USSR) (Engl. Trans.); 28: 119–21(Feb 1970).

Translated from Opt. Spektrosk.; 28: 217–22(Feb 1970).

Argon ions were excited by collisions of low-energy electrons with neutral atoms. The functions and effective cross sections of excitation of spectral lines of Ar II, whose upper levels are the states of the $3p^44p$ configuration, were measured by the optical method. The excitation functions of the investigated quartet lines have one maximum, and the doublets have two. From the measurement data of spectral lines, the excitation cross sections were determined for eight levels of the $3p^44p$ configuration. The most effective excitation is observed at 50 to 110 eV. (auth)

39865 RESONANCE EXCITATION OF HELIUM BY ELECTRONS AT ENERGIES NEAR 60 eV. Heideman, H. G. M.; Huijnen, M. L. H.; Smit, C. (State Univ., Utrecht). Physica; 47: 159–64(29 Apr 1970).

The excitation of the 4^3S and 3^3P levels of helium by electron impact was studied by observing the light emission following the excitation of the levels concerned. The electron energy region considered extends from 55 to 62 eV. The measurements show that in this energy range a number of resonances occur in the optical excitation curves. These resonances, some of which have been observed previously in an electron scattering experiment, are probably caused by an indirect excitation process via intermediate compound states associated with doubly excited states of the neutral helium atom. (auth)

39866 DETERMINATION OF ABSOLUTE CROSS SECTIONS FOR EXCITATION OF n^1P LEVELS OF HELIUM BY ELECTRON IMPACT (30 TO 1000 eV). Van Eck, J.; De Jongh, J. P. (State Univ., Utrecht). Physica; 47: 141–58(29 Apr 1970).

The total cross sections σ for excitation of helium to the 2^1P, 3^1P, and 4^1P levels by electron impact (E_{e1} = 30 to 1000 eV) are determined from light intensities of the n^1P-1^1S transitions; the corresponding lines lie in the extreme ultraviolet wavelength range. The radiation is detected by a vacuum monochromator. In determining the cross sections the influence of cascading from higher levels and the polarization degree of the emitted light are taken into account. To determine the polarization correction the light intensities are measured with the exciting electron beam parallel and perpendicular to the grooves of the monochromator grating. From theory it is known that for an allowed dipole transition the σE_{e1} versus $\ln E_{e1}$ graph gives a straight line in the Bethe–Born approximation for sufficiently large energies; the slope of this line is determined by the optical oscillator strength. The relative cross sections (between 200 and 1000 eV) are plotted in such a graph and the value of the abcis at the point of intersection (c_n) is determined. With help of this value of c_n and by using the theoretical calculated optical oscillator strength to determine the slope, absolute cross sections are calculated from relative measurements. The absolute cross sections determined in this way, differ about 3% from the very accurately calculated cross sections of Kim and Inokuti for the 2^1P and 3^1P levels and about 6% for the 4^1P level in the energy range of 150 to 1000 eV. However, these differences are of the same size as the (total) error. (auth)

39867 HEAVY-PARTICLE IMPACT IONIZATION OF ATOMS IN CLASSICAL THEORY. Tripathi, D. N.; Rai, D. K. (Banaras Hindu Univ., India). J. Phys. Soc. Jap.; 29: 403–8 (Aug 1970).

Heavy-charged-particle (proton, deuteron, and He^+ ion) impact ionization cross sections of the noble gas atoms were calculated using Gryzinski's formula with an exponential velocity distribution function. Low-energy behavior of the cross-section formula is investigated and the threshold expression given by Gryzinski is found to be incorrect. Dependence of the cross section on the mass of the system is also discussed. (auth)

39868 MULTIPLE IONIZATION OF Ca, Sr, AND Ba BY ELECTRON IMPACT. Okudaira, Sadayuki (Tokyo Metropolitan Univ.). J. Phys. Soc. Jap.; 29: 409-15(Aug 1970).

Ionization efficiency curves (IE curves) of Ca, Sr, and Ba by electron impact in the energy range from the ionization potentials to 1000 eV are obtained with a mass spectrometer having a crossed-beam ion source. The ions having up to three-fold positive charges are studied. The IE curves of Ca^+, Sr^+, and Ba^+ have some structures that correspond to autoionization processes. They are observed at 25.5 eV and 28.5 eV for Ca^+, 19 eV, 21.5 eV, and 24 eV for Sr^+, and 15 eV and 19 eV for Ba^+. The IE curves of Ca^{2+}, Sr^{2+}, and Ba^{2+} have remarkable breaks at 30 eV, 27.5 eV, and 20 eV, respectively, which are attributed to Auger processes, and many humps are observed below the breaks in the IE curves of Ca^{2+} and Sr^{2+}. The IE curve of Ba^{3+} has a break at about 86 eV, which is also attributed to an Auger cascade. The relative abundance ratios of the multiply charged ions to the singly charged ions obtained at 500 eV are compared with those of other works. (auth)

39869 CHARACTERISTICS OF EXPERIMENTAL APPARATUS FOR ELECTRON–ATOM COLLISIONS. Oda, Nobuo; Nishimura, Fumio; Tahira, Sadamu (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Technol. (Engl. Ed.); No. 96, 27-54(Mar 1970).

An ultrahigh-vacuum collision apparatus was constructed for studies of electron–atom collisions. The design principles as well as the characteristics of the constituent components are described, and some results obtained with this apparatus are given. (auth)

39870 QUASI-FREE SCATTERING OF ELECTRONS ON ATOMS. Amaldi, Ugo Jr. Ann. Ist. Super. Sanita; 5: 680-92 (1969).

The meaning of quasi-free scattering reactions and the application of the technique to the study of systems containing bound electrons are reviewed. Some experimental work in the field is summarized briefly. Possibilities for improvements in the techniques and technical problems still to be solved are discussed. It is concluded that quasi-free scattering reactions are a useful tool in studying the structure of bound systems and extension of the technique to atomic and molecular physics is expected to give new and useful information on the single-particle nature of atoms, molecules, and crystals. (A.G.W.)

39871 APPLICATION OF A MULTIPOLE POTENTIAL IN A THEORETICAL INVESTIGATION OF COLLISION CROSS SECTIONS FOR IONS WITH LINEAR MOLECULES. Hyatt, D.; Stanton, L. (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A; 318: 107-18(21 Jul 1970).

A theoretical study was made of the effects of permanent dipoles and quadrupoles on the cross sections of ion–neutral collisions. The angular dependence of the multipole potential is investigated and its implications regarding experimental results are described. Anisotropy in the polarizability as it influences cross sections was also studied. For linear molecules the theory indicates that large deviations from the cross sections predicted by a simple Langevin treatment will be visible if the neutral is selected according to its rotational state, but that "bulk" experiments will only be weakly affected by the presence of angle-dependent terms in the multipole expansion. (auth) (UK)

39872 DISTORTED WAVE CALCULATION OF THE ANGULAR DISTRIBUTIONS OF ELECTRONS INELASTICALLY SCATTERED ON ATOMS. Shelton, W. N.; Mix, J. B. (Florida State Univ., Tallahassee). Phys. Lett.; 32A: 285-6(27 Jul 1970).

The accuracy of the distorted-wave method for calculating differential cross sections for inelastic electron scattering is tested by comparing its results with close-coupling calculations for the 1s–2s excitation of atomic hydrogen. Comparison is also made with plane-wave theories. Considerable improvement over the plane-wave theories is found. (auth)

39873 MOLECULE–ATOM TOTAL SCATTERING CROSS SECTIONS: LiF ON Ar, Kr, AND N_2. Richman, E.; Wharton, L. (Univ. of Chicago). J. Chem. Phys.; 53: 945-56(1 Aug 1970).

Total quantum-mechanical scattering cross sections of LiF on Ar, Kr, and N_2 were measured as a function of collisional velocity in the thermal energy range, to about 1 to 2% accuracy, through the use of circular beam geometry and a McLeod gauge to measure target gas density. Good absolute agreement with the Schiff–Landau–Lifshitz elastic scattering theory and the calcuated $1/r^6$ long-range potential was obtained at only the lowest experimental velocities. At higher velocities the cross section is larger than predicted by this theory. No glory undulations were detected. Forces arising from the higher-order multipoles are insufficient to explain the results, but molecular protrusion correlates with the ordering of the deviations observed. (auth)

39874 NONITERATIVE SOLUTIONS OF INTEGRAL EQUATIONS FOR SCATTERING. IV. PRELIMINARY CALCULATIONS FOR COUPLED OPEN CHANNELS AND COUPLED EIGENVALUE PROBLEMS. Sams, W. Neal; Kouri, Donald J. (Univ. of Houston, Tex.). J. Chem. Phys.; 53: 495-501(15 Jul 1970).

The homogeneous integral solution formalism developed by Sams and Kouri is illustrated for coupled open-channel scattering calculations and coupled eigenvalue calculations. This method for scattering calculations compares favorably, both in accuracy and in computation time required, with the Lester–Bernstein close-coupling solution of the differential equations for scattering and the Johnson–Secrest amplitude density method. Preliminary results for coupled eigenvalue integral equations are also encouraging. A simple technique for applying the quantization condition in searching for the eigenvalues of coupled integral equations is presented, and is employed in the calculations reported. Example results are given for 16, 23, and 30 coupled scattering channels and for 1, 2, and 3 coupled integral eigenvalue equations. (auth)

39875 OPACITY ANALYSIS OF INELASTIC MOLECULAR COLLISIONS. IV. STATISTICAL ASPECTS OF ROTATIONAL EXCITATION THEORY. Levine, R. D. (Ohio State Univ., Columbus); Bernstein, R. B. J. Chem. Phys.; 53: 686-93 (15 Jul 1970).

Cross sections for specified rotational transitions of diatomic molecules are expressed in terms of opacity functions in the dominant-coupling regime and in the limited-coupling domain (where only first-order-allowed transitions occur). The statistical approximation is used to evaluate the opacity functions in the dominant coupling (the "inner") region. The "outer" zone of limited coupling includes the large angular momenta where the Born (or distorted-wave) approximation is satisfactory, as well as the region of somewhat lower J requiring numerical treatment (at least the solution of a limited set of coupled equations). The use of the statistical approximation for direct transitions is discussed in terms of a limited energy average of the S matrix. The vanishing of the average of the diagonal S matrix elements is sufficient for a simple statistical estimate of the total cross section; however, a much more stringent requirement must be met (vanishing of the averaged S matrix itself) for statistical prediction of specific inelastic transition probabilities. (auth)

39876 OPTICAL IONIZATION–EXCITATION FUNCTIONS OF ZINC, CADMIUM, AND MERCURY BY ELECTRON IMPACT. Anderson, Richard J. (Univ. of Arkansas, Fayetteville); Lee, Edward T. P. J. Chem. Phys.; 53: 754-9(15 Jul 1970).

The cross sections for the production of 16 lines of the Zn II, Cd II, and Hg II spectra by ionization–excitation collisions between electrons and neutral atoms were measured over the energy range 0 to 260 eV. The spectral lines are characterized by optical excitation functions to reach their maximum values within the energy range 40 to 90 eV, and by emission cross-section values of approximately 10^{-17} to 10^{-20} cm^2 at 200 eV. Theoretical branching ratios were calculated and are used with the experimental data to obtain estimates of the $7^2S_{\frac{1}{2}}$ (Hg^+), $6^2S_{\frac{1}{2}}$ (Cd^+), and $5^2S_{\frac{1}{2}}$ (Zn^+) direct excitation cross sections. Corresponding theoretical cross sections are estimated by means of the Born approximation. The cross-section ratios $Q(n^2P_{\frac{3}{2},\frac{1}{2}})/Q(n^2D_{\frac{3}{2}})$ are calculated for Zn^+ (n = 5), Cd^+ (n = 5), and Hg^+ (n = 7), and the results compared with experiment. (auth)

39877 APPROXIMATE VELOCITY DEPENDENCE OF THE TOTAL CROSS SECTION. Reck, G. P.; Hood, R. J. (Wayne State Univ., Detroit). J. Chem. Phys.; 53: 1131-3(1 Aug 1970).

The approximate velocity dependence of the forward scattering amplitude obtained by application of the Landau–Lifshitz procedure to an LJ (6–12) potential is compared to other work and discussed. (auth)

39878 EMISSION CROSS SECTIONS OF N_2 IN THE VACUUM ULTRAVIOLET BY ELECTRON IMPACT. Ajello, Joseph M. (Univ. of Colorado, Boulder). J. Chem. Phys.; 53: 1156-65 (1 Aug 1970).

The electron-beam excitation spectrum of N_2 at low pressure (0.12 to 0.18 μ) in the wavelength range 1200 to 2000 Å was recorded for monoenergetic electron impact energies from 10 to

208 eV. The spectral features observed were the Lyman–Birge–Hopfield vibrational transitions ($a^1\Pi_g \rightarrow {}^1\Sigma_u^+$) and several atomic nitrogen multiplets produced by dissociative excitation of N_2. The emission cross sections of the Lyman–Birge–Hopfield vibrational transitions were measured and summed to give the cross section for the entire electronic transition. The energy dependence of all vibronic transitions was the same. The atomic nitrogen transitions studied were the multiplets at 1200 Å ($^4P \rightarrow {}^4S^0$) 1493 Å ($^4P \rightarrow {}^2D^0$), and 1743 Å ($^4P \rightarrow {}^2P^0$). These emissions originated from dissociative excitation of molecular nitrogen. The emission cross sections of these transitions typically have two thresholds, corresponding to dissociative excitation of N_2 into two nitrogen atoms and to dissociative ionization excitation into an atom and an ion. (auth)

39879 SCATTERING OF LOW-VELOCITY NEUTRAL PARTICLES: THE Cs–He, Cs–Kr, AND Cs–Xe INTERACTIONS. Colgate, S. O. (Univ. of Florida, Gainesville); Imeson, T. C. J. Chem. Phys.; 53: 1270-5(1 Aug 1970).

Total scattering cross sections Q were measured for Cs atoms velocity-selected from thermal beams scattered by He, Kr, and Xe gases. Over the available range of relative velocities, the observed Cs–Kr and Cs–Xe cross sections vary in accordance with scattering by a central-field attractive potential of the form $U(r) = -C_6r^{-6}$. Observed values of C_6 in units of 10^{-58} erg · cm^6 are 4.7 ± 0.4 and 8.1 ± 0.7 for the Kr and Xe interactions, respectively, and are in good agreement with available theoretical estimates. The velocity range of the Cs–He measurements was too small to permit accurate determination of the force law, but the total cross section at a relative velocity of 1.30×10^5 cm/sec was found to be 177 ± 9 Å^2. (auth)

39880 ROTATIONAL EXCITATION DURING ION–MOLECULE COLLISIONS. Liu, Chelcie (Univ. of California, Santa Barbara). J. Chem. Phys.; 53: 1295-6(1 Aug 1970).

A semiquantitative explanation of the dependence of rotational excitation on the energy and identity of the incident ion for "grazing" ion–molecule collisions is given. A formula for change of angular momentum in the collision is suggested. The explanation is compared with experimental results of others and general agreement is found. (A.G.W.)

39881 COMMENT ON "NONITERATIVE SOLUTIONS OF INTEGRAL EQUATIONS FOR SCATTERING." Newton, Roger G. (Indiana Univ., Bloomington). J. Chem. Phys.; 53: 1298-1300 (1 Aug 1970).

In comment and reply the usefulness of the procedure suggested by Sams and Kouri for noniterative solution of integral equations for scattering is discussed. An alternative procedure is considered briefly. (A.G.W.)

Atomic Theory

39882 Z-EXPANSION OF ATOMIC PROPERTIES. Musher, Jeremy I. (Yeshiva Univ., New York). Chem. Phys. Lett.; 6: 33-6(1 Jul 1970).

The expansion of the wave function of a ^2S atom in the presence of a scaled electric field ϵ' cannot be expanded simultaneously in $\lambda = Z^{-1}$, where Z is the nuclear charge, and ϵ'. The fact that λ cannot be used as an order parameter, equivalent to the breakdown of the usual perturbation theory expansion, is due to a degeneracy in the spectrum of H_2. This necessitates the partial summation of higher-order formal perturbation theoretic terms in order to remove an infinity in the leading term. The summation technique should be useful in other calculations on degenerate systems. (auth)

39883 VARIATIONAL METHOD FOR CALCULATING EXCITED-STATE WAVE FUNCTIONS. Cohen, Maurice; Feldmann, Tova (Hebrew Univ., Jerusalem). Chem. Phys. Lett.; 6: 43-5(1 Jul 1970).

A variational method for calculating an approximate excited-state wave function having maximum overlap with the corresponding exact wave function, recently employed by Messmer, is rederived from a generalization of the classical procedure of Weinstein. The method requires knowledge of the appropriate exact energy level, but no explicit constraints are required in the variation process. (auth)

39884 SYMMETRY PRINCIPLES AND ATOMIC SPECTROSCOPY. Wybourne, Brian G. New York; John Wiley and Sons, Inc. (1970). 325p. $17.50.

Relevant parts of the theory of the symmetric group and the general properties of group characters are outlined briefly. Littlewood's development of the theory of the symmetric and continuous groups in terms of the theory of S-functions is discussed with emphasis on the algebra of plethysm. These principles are then applied to three problems in the theory of atomic spectra: (1) the symmetry classification of the atomic states of multielectron configurations, (2) the analysis and classification of the many-body operators that arise in the application of perturbation theory to atomic problems, and (3) the application of selection rules in evaluating the matrix elements of interactions. Extension tables of group properties are included in an appendix. 149 references. (A.G.W.)

39885 REGULAR WAVEFUNCTIONS FOR ATOMIC THREE- AND FOUR-PARTICLE SYSTEMS. Kalotas, T. M. (La Trobe Univ., Bundoora, Australia); Lloyd, M. H.; Delves, L. M. Aust. J. Phys.; 23: 239-42(Jun 1970).

A set of regularity conditions on the wave function are written down, which are sufficient to ensure that calculations with previously derived Euler angle reductions of the atomic three- and four-particle Schrödinger equation remain finite. (auth) (Australia)

39886 ELECTRONIC WAVE FUNCTIONS FOR ATOMS. III. PARTITION OF DEGENERATE SPACES AND GROUND STATE OF C. Bunge, Annik (Univ. of Florida, Gainesville. Univ. Central de Venezuela, Caracas). J. Chem. Phys.; 53: 20-8(1 Jul 1970).

The atomic configuration-interaction (CI) expansion is expressed in terms of constituents that are invariant under linear transformations of the radial one-electron basis. For open-shell states, the degenerate LS spaces are partitioned into maximal Hartree–Fock (HF) noninteracting spaces and minimal HF interacting spaces. This particular partition is shown to improve considerably the convergence of the atomic CI expansion, and it may be applied to molecular CI expansions in terms of symmetry orbitals. An exhaustive calculation of the ground state of C is carried out. A well-defined linear transformation of the radial one-electron basis is made in order to improve further the convergence of the CI series. The final 234-term CI expansion (formed from a determinantal space of dimension 4836) obtained with an optimized 7s6p4d3f basis, gives an energy E = –37.83378 a.u. (C), accounting for more than 93% of the correlation energy. The C wave function is believed to be expressed in its most rapidly convergent form. The advantages of the present approach to atomic CI calculations are discussed. (auth)

39887 LOWER BOUNDS FOR OVERLAP. II. DERIVATION OF THE ECKART FORMULA. Wang, P. S. C. (Univ. of Georgia, Athens). J. Chem. Phys.; 53: 466-7(1 Jul 1970).

The method of resolvent operators is used to derive the Eckart bound for the overlap of an approximate (normalized) wave function and the true (normalized) ground-state wave function of a quantum mechanical system. An upper bound, which is a special case of the upper bound of Rayner, is also derived. (A.G.W.)

39888 HYDROGEN ATOM AND THE CONFORMAL GROUP. Rumer, Yu. B. (Novosibirsk State Univ., USSR). Dokl. Akad. Nauk SSSR; 191: 64-6(1 Mar 1970). (In Russian).

An attempt was made to find the most direct method of expressing Schrödinger's equation for the hydrogen atom through the generators L_{ab} of a conformal group, which satisfied the following permutational relationship: a,b = 0, 1, 3, 3; 5, 6; $g_{ab} = +,-,-,-;-,+$; $[L_{ab}, L_{cd}] = i(g_{ad}L_{bc} + g_{bc}L_{ad} - g_{ac}L_{bd} - g_{bd}L_{ac})$. The 15 L_{ab} generators include the Lorentz group and 9 additional generators that constitute the shift operators of the conformal transformation and dilation. The transformation involves 3 stages: Heisenberg's representation, canonical transformation, and Schrödinger's equation. The derived complex generator has discrete specific values for which the discrete spectrum may be obtained; the noncompact generator yields the continuous spectrum. (TTT)

39889 MANY-BODY PERTURBATION THEORY FOR MOLECULES BASED ON A UNITED ATOM MODEL. Lee, T.; Dutta, N. C.; Das, T. P. (Univ. of Utah, Salt Lake City). Phys. Rev. Lett.; 25: 204-8(27 Jul 1970).

The linked-cluster many-body perturbation theory is developed for molecules using the united atom as a starting point. Specific application is made to hydrogen fluoride with neon as the united atom. The calculated energy for the molecule is found to be –100.4186 a.u. in excellent agreement with the experimental value of –100.4485 a.u. The theoretical correlation energy is found to be 92% of experiment. Satisfactory agreement is also obtained for the electric field at the fluorine nucleus. (auth)

39890 THREE APPROACHES TO ELECTRON CORRELATION IN ATOMS. Sinanoglu, Oktay; Brueckner, Keith A. Yale Series in the Sciences. A Chemistry–Physics Interface. New Haven; Yale University Press (1970). 396p. $22.50.

The three approaches presented were developed since 1960.

They deal with correlation effects systematically starting from different physical points of view. They are (1) the theory of pair correlations and the many-electron theory of atoms and molecules, (2) the atom viewed as a nonuniform electron gas, and (3) diagrammatic many-body perturbation techniques. The presentation consists of a discussion of each approach followed by reprints of papers from the original literature. A brief background on the relevant orbital Hartree–Fock theory and a summary of the historical methods that preceded the modern approaches are included. (A.G.W.)

39891 PERTURBATION THEORY OF SHORT-RANGE ATOMIC INTERACTIONS. Byers-Brown, W.; Power, J. D. (Univ. of Manchester, Eng.). Proc. Roy. Soc. (London), Ser. A; 317: 545-74(7 Jul 1970).

A new united-atom perturbation theory of the interaction of two atoms at small separations is described. The key feature is a similarity transformation of the Schroedinger equation, which enables the cusp conditions to be satisfied at both nuclei and preserves the correct molecular symmetry. The first-order theory is examined in detail and compared with other united-atom theories. Numerical calculations are presented for the ground states of the systems H_2^+, HeH^{2+}, HeH, He_2, and Li^+He, based mainly on Hartree–Fock wave functions for the united atoms, and are compared with accurate molecular calculations. The agreement is remarkably good for separations up to 1 Bohr. (auth) (UK)

Cosmic Radiation

Refer also to abstracts 39362, 39771, 39977, 40241, 40271, and 40360.

39892 (AD–704883) ATMOSPHERIC GAMMA-RAYS AT BALLOON ALTITUDES. Cortellessa, Paolo; Di Benedetto, Paolo; Paizis, Constantinos (Milan Univ. (Italy). Istituto di Fisica). 1969. Contract F61052-68-C-0050. 11p. CFSTI.

The omnidirectional intensity of atmospheric gamma rays at balloon altitudes was measured at three energy thresholds. A value was found for energies greater than 20 MeV. A flattening of the integral spectrum was observed at lower energies. (auth) (USGRDR)

39893 (AECL–3608) COSMIC RAY NEUTRON AND MUON MONITOR DIURNAL VECTORS. III. From the Start of Solar Rotation No. 1826 to the End of Solar Rotation No. 1839, January 6, 1967–January 18, 1968, and Vector Diagrams by Solar Rotation. Steljes, John F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Deep River Lab.). Apr 1970. 123p. Dep. CFSTI (U. S. Sales Only). AECL $2.00.

Daily diurnal and semi-diurnal variation vectors for both the muon and the neutron monitors at four cosmic-ray stations in Canada that have equipment maintained by AECL are given in tabular form for the period from the start of solar rotation No. 1826 to the end of rotation No. 1839. The same vectors for the AECL neutron and muon monitors at Kula, Hawaii, and for the Bolivian neutron monitor at Chacaltaya, are also given. The vectors were corrected for barometer and in the case of the muons, except at Kula, for the atmospheric temperature wave using hourly values of the temperature and barometric pressure measured near the ground. Graphs of the vectors at each station for successive solar rotations are also given. (auth)

39894 (AECL–3651) COSMIC RAY NEUTRON AND MUON MONITOR DIURNAL VECTORS. IV. From the Start of Solar Rotation No. 1840 to the End of Solar Rotation No. 1852, January 19, 1968–January 3, 1969, and Vector Diagrams by Solar Rotation. Steljes, John F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Deep River Lab.). May 1970. 117p. Dep. CFSTI (U. S. Sales Only). AECL $2.00.

39895 (AECL–3658) COSMIC RAY NEUTRON AND MUON MONITOR DIURNAL VECTORS. V. From the Start of Solar Rotation No. 1853 to the End of Solar Rotation No. 1866 (January 3, 1969–January 16, 1970) and Vector Diagrams by Solar Rotation. Steljes, John F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jun 1970. 127p. Dep. CFSTI (U. S. Sales Only). AECL $2.50.

Daily diurnal and semi-diurnal variation vectors for both the muon and the neutron monitors at 4 cosmic-ray stations in Canada that have equipment maintained by AECL are given in tabular form for the period from the start of solar rotation No. 1853 to the end of rotation No. 1866. The same vectors for the AECL neutron and muon monitors at Kula, Hawaii, and for the Bolivian neutron monitor at Chacaltaya, are also given. The vectors were corrected for barometer and in the case of the muons, except at Kula, for the atmospheric temperature wave using hourly values of the temperature and barometric pressure measured near the ground. Graphs of the vectors at each station for successive solar rotations are also given. (auth)

39896 SECULAR VARIATIONS IN COSMIC-RAY CUTOFF RIGIDITIES. Shea, M. A.; Smart, D. F. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res.; 75: 3921-2(1 Jul 1970).

The procedure for determining cosmic-ray cutoff rigidities has been by tracing the orbits of the particles through a high-degree simulation of the geomagnetic field, using coefficients for Epoch 1955. The application of the cutoff rigidities to data acquired during a different epoch ignores the secular variation in the geomagnetic field. Using data of previous calculations, a set of field coefficients appropriate for Epochs 1935, 1945, and 1955, and 1965 were determined. The differences in vertical cutoff rigidity calculated by using different field models for the same epoch were evaluated. (J.C.W.)

39897 NEW DATA ON THE ABSOLUTE COSMIC-RAY IONIZATION IN THE LOWER ATMOSPHERE. George, Michael J. (California Inst. of Tech., Pasadena). J. Geophys. Res.; 75: 3693-3705(1 Jul 1970).

An air-filled ionization chamber was constructed with a volume of 552 liters and a wall consisting of 12.7 mg/cm^2 of aluminized plastic wrapped over a rigid, lightweight aluminum frame. A calibration in absolute units, independent of previous Caltech ion-chamber calibrations, was applied to a sealed Neher electrometer for use in this chamber. With this chamber and an older, argon-filled balloon chamber in a C-135 aircraft, the ionization in the atmosphere from 1000 to 40,000 feet was measured. Other measurements off the southern California coast, primarily with the balloon chamber, resulted in a value of 2.60 ± 0.03 ion pairs/cm^3 sec atm for the cosmic-ray ionization at sea level. The calibration of the 552-liter ion chamber agrees with the old Caltech calibration to within 1%, and the airplane data were consistent with previous balloon measurements in the upper part of the altitude range. Data on the fluctuations of ionization due to radon and its daughters in the atmosphere are presented. New ionization values are lower than previous Caltech values but higher than more recently reported values. (auth)

39898 COSMIC X RAYS AND γ RAYS. Ipavich, Fred M.; Lenchek, Allen M. (Univ. of Maryland, College Park). Phys. Rev., D; 2: 266-70(15 Jul 1970).

The observed diffuse x- and γ-ray spectrum is analyzed, and consequences are deduced for Compton-scattering models in intergalactic space. The putative far-infrared radiation is examined for its effects on (1) interpretation of the diffuse x- and γ-ray observations, (2) Compton-scattering models in galactic and intergalactic space, and (3) the cosmic-ray electron spatial distribution in our galaxy. (auth)

39899 PARTICLE DIFFUSION IN A CLOUD OF OUTGOING SCATTERING CENTERS. Perona, Giovanni E. Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 104: 179-91(Mar-Apr 1970).

The Boltzmann equation describing diffusion of relativistic particles in a spherical cloud of outgoing scattering centers was solved, using the method of extension. The distribution function is expanded in powers of the velocity V_0, and the zero-order term in the expansion was computed together with the first term function of the angle θ. The range of validity of these results is determined by the inequalities. Upon substitution in those relations of V_0 and R with the solar-wind velocity normalized with respect to c and the radius of the solar-wind cavity, normalized with respect $1/(4\pi N_0 \sigma_0)$, it is immediately seen that the present results can be applied to the modulation of high-energy cosmic rays by the solar wind. It is relatively easy to extend the procedure to a more general situation with N and σ functions of the velocity v. In doing so the mathematics becomes more complicated, but no new analytical difficulty will appear. (auth)

39900 OBSERVATION OF LARGE AIR SHOWER. Akiyama, Hiromitsu; Kamaguchi, Setsuo (Tokyo Univ.). Uchusen Kenkyu; 14: 306-12(Oct 1969). (In Japanese).

Importance of the observation of large-size air showers has been realized since the discovery of 3°K blackbody radiation by Penzias et al. The rapid decrease in the energy spectrum of the primary cosmic rays with energy higher than 3×10^{19} eV was predicted from γ + p reactions with the 3°K radiation. The largest air shower ever found was that at Volcano Ranch with the energy 10^{20} eV. The method for the observation of large air showers is briefly discussed. At the Institute for Nuclear Study, the observation of large air shower has been continued since 1967. One method

is the observation of radio echo with the reflected loran waves from the atmospheric ions produced by the shower. The other is the measurement of the decoherence curve. This latter method is discussed in detail. The block diagrams of circuits and the location of observation posts are shown. Technical difficulties were found associated with the timing with coincidence pulses. The future program for improvements is shown. (JAERI)

39901 MUONS FROM COSMIC RADIATION: A LABORATORY EXPERIMENT. van Klinken, J. (Univ., Groningen, Netherlands). Ned. Tijdschr. Natuurk.; 35: 310-13(Sep-Oct 1969). (In Dutch).

The decay of a muon into an electron and two neutrinos may be measured by means of a relatively simple technique. The cosmic muon flux of about 1 muon/cm^2/min^{-1} consists of 45% of μ^- and 55% of μ^+. The experimental setup consisted of a scintillator, a photomultiplier and an oscilloscope; passage of a muon through the scintillator causes a pulse. One muon in 10^3 is stopped within the scintillator, causing a second decay pulse about 2 μsec after the first one. The NaI scintillator gave the expected half life for muon decay, but the $T_{\frac{1}{2}}$ determined by means of a plastic tube-type scintillator was consistently shorter than the anticipated value. This shorter value is attributed to the capture of a μ^- meson. The $T_{\frac{1}{2}}$ for the capture process depends on the Z value and varies from 1.9 μsec for carbon to 0.05 μsec in heavy elements, with a Z of about 85. There were indications that the μ^- capture causes stronger pulses than the decay of μ^-. This experiment is used for laboratory instruction at the graduate level. The visual observation technique makes the experiment suitable for instruction at a lower level. (TTT)

39902 MUONS FROM COSMIC RADIATION: THE UTAH EXPERIMENT. de Graaf, Tj.; van Klinken, J. (Univ., Groningen, Netherlands). Ned. Tijdschr. Natuurk.; 35: 301-9(Sep-Oct 1969). (In Dutch).

High-energy neutrinos and muons are counted deep underground, using large counting areas and very long counting times. When extragalactic protons hit the atmospheric nitrogen and oxygen molecules, π mesons and K mesons are created; they may be absorbed or may decay to a muon and a neutrino. The muon formation depends on the zenith angle. For each muon, the path through the rock strata must be extrapolated. Streamer chambers and Cherenkov counters are used as detectors. Atmospheric muons are about 10^5 times more numerous than high-energy cosmic muons; the latter may be identified by their upward movement. New relationships are proposed for differential muon spectra, including an istropic parameter R for an as yet unexplained effect which may be due to muon formation directly through collision with matter in the atmosphere, through decay of short-lived intermediate particles, by an isotropic component of the cosmic radiation or excessive muon formation above 100 GeV through K decay. This isotropic effect was confirmed also by measurements in the Soviet Union. (TTT)

39903 FIZIKA KOSMICHESKIKH LUCHEI. (Physics of Cosmic Rays). Murzin, V. S. Moscow; Izdatel'stvo Moskovskogo Universiteta (1970). 288p.

The text book covers the problems of cosmic-ray physics and high-energy particle interactions. Experiments and specific methods used in cosmic-ray studies are described. Interactions of the initial radiation with magnetic fields and substances and the origin of cosmic rays are discussed. (R.V.J.)

39904 MODULATION OF THE INTENSITY OF GALACTIC COSMIC RAYS BY THE SOLAR WIND IN THE PRESENCE OF AZIMUTHAL ASYMMETRY. Belov, A. V.; Dorman, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 783-90(1969).

Translated from Geomagn. Aeron.; 9: 972-81(1969).

The expected density distribution of galactic cosmic rays in the presence of a sharply defined azimuthal asymmetry of the flux of magnetic inhomogeneities from the Sun is found on the basis of the steady-state equation of the isotropic diffusion of cosmic rays in interplanetary space. (auth)

39905 EFFECT OF METEOROLOGICAL FACTORS ON THE INTENSITY FLUCTUATIONS OF THE NEUTRON COMPONENT OF COSMIC RAYS. Alkhababyan, N.; Georgieva, M. Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 791-4(1969).

Translated from Geomagn. Aeron.; 9: 982-6(1969).

The effect of meteorological factors on the intensity of the neutron component of cosmic rays was investigated by studying its intensity fluctuations. The average diurnal values obtained during 3 months of operation of a neutron monitor on Musala Peak were used. It was found that intensity fluctuations, not corrected for meteorological effects, do not have a normal distribution. The introduction of a correction for the barometric effect reduces the fluctuations and their distribution becomes normal. Additional introduction of corrections for the temperature of the atmosphere at the recording site reduces the intensity fluctuations of the neutron component even more. (auth)

39906 STATISTICAL ANALYSIS OF COSMIC-RAY INTENSITY INCREASES BEFORE FORBUSH EFFECTS. Dorman, L. I.; Kaminer, N. S.; Kebuladze, T. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Inst. of Geophysics, Tbilisi, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 864-5(1969).

Translated from Geomagn. Aeron.; 9: 1069-70(1969).

Data relating to the neutron component of cosmic rays obtained at the Climax high-mountain station from 1957 to 1961 were used to study the cosmic-ray intensity increase before Forbush effects. The relationship between the amplitude of the increase and the average 3-hour index of geomagnetic activity 24 hours before a Forbush decrease, the delay time of the commencement of a geomagnetic storm with respect to a chromospheric flare, the solar longitude of the flare, the difference between the solar latitudes of the chromospheric flare and the earth, and the energy spectrum of primary cosmic rays was studied. The statistical analysis showed the important role of the factor determined by the difference in the solar latitudes of the earth and of the chromospheric flare in the increase in cosmic rays on earth. (J.C.W.)

39907 27-DAY RECURRENCE OF DIURNAL COSMIC-RAY VARIATIONS. Danilov, A. A.; Morozova, S. O. (Inst. of Cosmophysical Research and Aeronomy, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 868(1969).

Translated from Geomagn. Aeron.; 9: 1074(1969).

The superposition of epochs method was used to study the 27-day recurrence of cosmic-ray anisotropy. The diurnal variation was found: (1) to have a 27-day modulation associated with the period of the rotation of the sun; (2) to be shifted with respect to the principal day of a magnetic storm by 3 days; and (3) to be most distinct when days with magnetic disturbances produced by low-latitude active regions in the northern hemisphere of the sun were used as zero days. (J.C.W.)

Direct Energy Conversion

Refer also to abstract 39159.

39908 (INR-1159) CRITICAL CHANNEL LENGTH OF THE HALL-TYPE MHD GENERATOR. Celinski, Z. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 21p. Dep. CFSTI (U. S. Sales Only).

When the gas parameters vary strongly along the channel, the critical length of the Hall generator may appear. Its magnitude depends on the distribution functions of the gas parameters. With the increase of the generator duct above the critical length, the produced electrical power will be decreased. The considerations were completed by the numerical calculations for the assumed distribution functions of the gas velocity, gas conductivity, and the Hall parameter. End effects were also taken into account in the calculations. (auth)

39909 (RT/FI-(69)48) A DEVICE FOR THERMAL AND ELECTRICAL IONIZATION OF ALKALI VAPOURS IN NOBLE GAS ATMOSPHERE, WITH ACCESSIBILITY FOR OPTICAL ELECTRICAL AND MICROWAVE DIAGNOSTICS. Boschi, A.; Merzagora, N. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratorio Conversione Diretta). [1969]. 33p. Dep. CFSTI (U. S. Sales Only).

The device described here is designed to generate thermal ionization of an alkali vapor (cesium 0.2 to 20 torr) in thermodynamic equilibrium within a steady atmosphere of noble gas (helium 100 to 1500 torr) contained inside an electrically insulating hot chamber (at 1000 to 2000°K). This device is used to investigate the nonequilibrium ionization phenomena occurring there, in the presence of a diffused electrical discharge and an applied magnetic field. The chamber is accessible to optical (in the visible and near-infrared), microwave (in the millimetric wavelength range), and electrical diagnostics. (auth)

39910 DEVELOPMENT OF THE THEORY OF LOW-VOLTAGE ARCS IN THERMIONIC CONVERTERS WITH DENSE PLASMA. Bakshi, F. G.; Korobova, I. L.; Moizhes, B. Ya. Zh. Tekh. Fiz.; 40: 843-54(Apr 1970). (In Russian).

The state of the gas-discharge plasma in thermionic converters was calculated at high current densities across the apparatus [$j \approx 10$ to 50 A/cm^2]. It was found that, at Pd $\gtrsim$ 1 torr mm, the plasma in the lower part of the device develops into a state of local thermodynamic equilibrium. The approximate boundary equations

usually used for calculation of the low-voltage arc in thermionic converters for ion currents in contact of the plasma with the electrodes and their effects on the calculation of the volt–ampere characteristics and magnitude of the field intensity on the cathode are analyzed. The Schottky effect on the cathode is taken into account and the mechanism of the current increase in the arc discharge is explained. The rate of the nonequilibrium ionization by the electron beam emitted by the cathode, and relaxing in the plasma because of paired electron–electron collisions, is calculated. It is found that because of the large concentration of free electrons in the plasma, the contribution of the nonequilibrium ionization can usually be neglected in comparison with the ionization from the Maxwellian electrons of the plasma. (tr-auth)

39911 FUNDAMENTAL PRINCIPLES OF AN ASYNCHRONOUS MHD GENERATOR IN THE AUTONOMOUS REGIME OF WORK. Tolmach, I. M.; Dronnik, L. M.; Yantovskii, E. I. Izv. Akad. Nauk SSSR, Energ. Transp.; No. 2, 77-84(Mar-Apr 1969). (In Russian).

Previously, the theoretical investigation of an asynchronous MHD generator was completed during electrical network analysis. The autonomous regime is analyzed here and the system of equations of such a regime is obtained, considering mean values and first harmonic variables. Certain results of the experimental investigation of an autonomous asynchronous MHD generator are given. (tr-auth)

39912 CRITIQUE OF MHD POWER GENERATION. Jackson, William D. (Avco Research Lab., Everett, Mass.); Petrick, Michael; Klepeis, James E. J. Eng. Power; 92: 217-30 (Jul 1970).

Magnetohydrodynamic electrical power generation has been explored intensively but on a small scale during the past ten years, and the initial enthusiasm in it has been confirmed. Its utilization in base-load plants, in addition to increasing overall efficiency, can also lead to important reductions in the adverse environmental effects of thermal and air pollution. The projected efficiencies of large dual-cycle systems are initially in the range of 47 to 50%, and improvements in technology could later increase this to 60%. Various MHD power cycles and systems are under consideration. The status of these systems is reviewed with emphasis on their application to large central-station commercial systems. The major technological problems and progress in the three major cycles (open cycle, closed-cycle plasma, and closed-cycle liquid metal) are discussed in depth. In the open-cycle system, the engineering solutions that have been proposed for the major problems in the generator and auxiliary equipment are detailed. In addition, the experience gained from the operation of a succession of generators is summarized. In the case of the closed-cycle plasma system, the progress that has been made toward developing a generator with the requisite conversion efficiency is cited. Recent cycle analyses that have established the conditions for matching these systems to current heat sources are also reviewed and their implications noted. The potential of developing liquid-metal MHD systems for commercial application is explored in the light of recently obtained experimental and analytical performance information. In particular, promising new techniques that can lead to improved efficiencies are detailed. (auth)

39913 CRITICAL CHANNEL LENGTH OF THE HALL-TYPE MHD GENERATOR. Celinski, Z. Arch. Elektrotech. (Warsaw); 19: 305-13(1970).

When the gas parameters vary strongly along the channel, the critical length of the Hall generator may appear; its magnitude depends on the distribution functions of the gas parameters. With the increase of the generator duct above the critical length, the electrical power production will be decreased. Numerical calculations for the assumed distribution functions of the gas velocity, gas conductivity, and the Hall parameter are presented. End effects are taken into account in the calculations. (auth)

39914 TRANSPORT PHENOMENA IN PARTIALLY IONIZED CESIUM. Andersen, Rodney J.; Nighan, William L. (United Aircraft Research Labs., East Hartford, Conn.). J. Appl. Phys.; 41: 3750-8(Aug 1970).

An analysis of electron and ion transport phenomena in cesium plasma is developed in a form consistent with experimental conditions typical of those in thermionic and magnetohydrodynamic energy converters and other cesium discharges. Particular attention is given to electron collision processes shown to influence significantly both electron and ion transport phenomena. Using available electron cross-section data, electron and ion transport coefficients are evaluated as a function of electron temperature and fractional ionization. Results are then applied to the plasma of a low-pressure nonuniform thermionic arc. Experimentally determined spatial variations of electron density and electron temperature are analyzed numerically, and quantitative estimates are made of the spatial variation of electric field intensity, ion current density, and net charged-particle production rate. The inferred production rate is compared with that evaluated using a nonequilibrium kinetic analysis developed by Norcross and Stone. (auth)

Fluid Physics

Refer also to abstract 39128.

39915 EFFECT OF A TRANSVERSE MAGNETIC FIELD ON A PROPAGATING PLANE GASEOUS DETONATION WAVE. Thomas, John Peter. Tucson, Ariz.; Univ. of Arizona (1969). 153p.

Thesis.

An experimental investigation was made of the effect a transverse magnetic field has on certain characteristics of a propagating steady-state detonation wave. The wave characteristics measured were the propagation velocity and the variation in pressure behind the wave front. A theoretical calculation is also presented, based upon a simplified one-dimensional model for the wave propagating through the magnetic field, which predicts that there should be no observable changes in these characteristics. (Diss. Abstr. Int., B)

39916 MAGNETOHYDRODYNAMIC FLOW DUE TO AN AXIALLY OSCILLATING INFINITE CYLINDER. Arora, K. L.; Gupta, P. R. (Punjab Engineering Coll., Chandigarh, India). J. Math. Anal. Appl.; 30: 645-57(Jun 1970).

Magnetohydrodynamic flow due to finite-amplitude axial oscillations of an infinite cylinder (insulator) is considered. There is a radially applied magnetic field of the form k/r, where k is a constant and r the radial distance. First, inviscid conducting fluids are considered, then, the conductivity is taken to be infinite. The results are expressed in terms of interaction parameter in the first part and by a dimensionless quantity, the ratio of interaction parameter and magnetic Prandtl number, in the second part. In both cases, the induced magnetic field is found to be discontinuous at the surface of the oscillating cylinder. Other aspects such as skin friction, energy dissipation, induced current density, and electric field distribution are also studied. All the results have been expressed in their real forms, and for that purpose, a few relations in Bessel functions are derived. (M.H.R.)

39917 THE INFLUENCE OF THE RATE OF FLOW ON THE DISTRIBUTION OF CURRENTS IN A MAGNETOGASDYNAMIC CHANNEL. Korsun, A. G.; Levin, A. L. Zh. Prikl. Mekh. Tekh. Fiz.; No. 3, 20-6(May-Jun 1970). (In Russian).

A steady plane conducting gas flow across a magnetic field in a constant cross-section channel formed by finite-length electrodes and insulators was studied, considering the Hall effect. Assuming that the electromagnetic forces are small and using linear approximations, it is shown that the perturbation of compressed gas flow velocity resulted in closed currents in the channel and changed significantly the distribution of current on the electrodes. (tr-auth)

39918 STABILITY OF PLANE-PARALLEL MAGNETOHYDRODYNAMIC FLOW IN A TRANSVERSE MAGNETIC FIELD. Sagalakov, A. M.; Shtern, V. N. Zh. Prikl. Mekh. Tekh. Fiz.; No. 3, 127-31(May-Jun 1970). (In Russian).

The stability of viscous electroconductive plane-parallel fluid flow in a transverse magnetic field was studied within the limits of linear theory. The magnetic Reynold's numbers were assumed to be small and the critical Reynold's number was calculated as a function of various Hartmann numbers. Neutral curves were constructed for symmetric and antisymmetric perturbations. Destabilizing effects of the magnetic field were studied, in the case of Couette flow. Data obtained were correlated with the published data. It was found that the influence of the shape of the velocity profile on the small perturbation spectra and on the critical Reynold's numbers does not depend on those physical effects important in formation of the velocity profiles. (tr-auth)

39919 INFLUENCE OF THE FLOW OF A CONDUCTING FLUID PAST A SPHERE ON MAGNETIC FIELDS. Bois, Pierre-Antoine (Faculte des Sciences, Paris). J. Mec.; 9: 35-59 (Mar 1970). (In French).

The case considered is that of the uniform flow of a perfect, incompressible and electrically conducting fluid past a sphere in the presence of a magnetic field, when the magnetic Reynolds number and the interaction parameter are small. The magnetic field is calculated for the case of a magnetic dipole, whose axis is parallel to the flow and is located at the center of the sphere;

this field superposes another field, which is uniform and in the direction of flow. The drag on the sphere is calculated using a method due to Ludford. The variations of the drag coefficient are studied as a function of the magnetic Reynolds number. The ratio of the intensities of the applied magnetic field to that of induced magnetic field are studied for paramagnetic and ferromagnetic spheres. (tr-auth) (France)

39920 LAMINAR SOURCE FLOW BETWEEN TWO ROTATING DISKS IN PRESENCE OF A TRANSVERSE MAGNETIC FIELD. Khan, Mohd Abdul Allem (Univ. of Lucknow, India). J. Mec.; 9: 99-110(Mar 1970).

The flow of a viscous, electrically conducting, and incompressible fluid between two parallel coaxial rotating disks in the presence of a transverse magnetic field is studied, when there is a source at the center. (auth) (France)

39921 STUDY OF THE FLOW OF A CONDUCTING FLUID IN A CHANNEL USING THE MULTIPLE SCALES TECHNIQUE. Peyret, Roger (Univ., Paris). J. Mec.; 9: 61-97(Mar 1970). (In French).

The steady flow of an electrically conducting but perfectly compressible fluid in a semi-infinite channel in the presence of electric and magnetic fields is considered. The electromagnetic force is oblique to the axis of the channel and a two-dimensional motion is induced. The induced fields are neglected and the flow is calculated by means of an asymptotic expansion depending on the interaction parameter, N, which is assumed small. The so-called method of multiple scales is used. This allows an expansion of the solution which is valid near the entry of the channel and at large distances. (tr-auth) (France)

Geophysics (Upper Atmosphere)

Refer also to abstracts 39789 and 39905.

39922 (AD-704548) ON WATER CLUSTER IONS IN THE IONOSPHERIC D REGION. Environmental Research Papers. Narcisi, Rocco S. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Feb 1970. 17p. (AFCRL-ERP-314; AFCRL-70-89; CONF-680521-2). CFSTI.

From 4th International Conference on the Universal Aspects of Atmospheric Electricity, Tokyo, Japan.

Positive-ion composition measurements obtained with rocket-borne mass spectrometers in the lower ionosphere are presented. The current situation regarding the water-cluster ions in the D region is considered. Evidence is given in favor of an ambient instead of a contamination origin for the water-cluster ions, although the exact processes for the formation of these ions in the atmosphere are still not definitely established. A theory is discussed whereby water cluster ions may be created through the ionization of small water conglomerates, which are assumed both to be present in the mesosphere and to have very low ionization thresholds. (auth) (USGRDR)

39923 (AD-704817) DEPENDENCE OF THE OCCURRENCE OF CHORUS UPON THE LOCATION OF THE PLASMAPAUSE. Report for January 1966-September 1969. McPherson, Donald A.; Koons, Harry C. (Aerospace Corp., El Segundo, Calif.). 30 Jan 1970. Contract F04701-69-C-0066. 48p. (TR-66(9220-2)-3; SAMSO-TR-70-82). CFSTI.

vlf emissions at 1.3 kHz are observed at altitudes below 1500 km by a vlf receiver aboard spacecraft OV3-3. Correlations of these emissions with local time, magnetic latitude, and the planetary magnetic index Kp show that they have the same characteristic dependence with these parameters as have chorus emissions observed by other satellites and by ground-based stations. The altitude dependence of the magnetic field intensity agrees with that predicted for a wave propagating completely trapped on a tube of force without attenuation. The occurrence of the emission increases with Kp and depends upon the location of the plasmapause. As the plasmapause moves to lower L-shells, the emission occurs more often. A possible explanation for this dependence is the relationship between the growth rate of the Doppler-shifted cyclotron instability and the sharp decrease in electron density at the plasmapause. For frequencies near 1 kHz and electron energies in the range 0.05 to 1 MeV, the growth rate and region of maximum growth increase as the plasmapause moves to lower L shells, in agreement with the experimental data. (auth) (USGRDR)

39924 (AD-704820) BASIC RESEARCH ON AURORA AND AIRGLOW. Final Report, January 1-December 31, 1969. Rundle, Howard N.; Llewellyn, Edward J. (Saskatchewan Univ., Saskatoon. Inst. of Space and Atmospheric Studies). 31 Dec 1969. Contract F19628-69-C-0106. 40p. (AFCRL-70-149). CFSTI.

The instruments currently in use for the spectroscopic and photometric observation of aurora and airglow are listed together with modifications and new developments of instrumentation. Modifications were made to a two-channel rocket-borne photometer that is used for measuring 1.27-μ radiation. A birefringent photometer was modified to make it more useful for twilight measurements. Investigations were carried out on the rotational temperatures derived from OH emissions. Further observations of 1.27-μ oxygen emission were made from both the ground and rocket flights. These measurements and others were analyzed so that many of the temporal and spatial properties of this emission are now known. An auroral component of this emission was also investigated. Considerable theoretical investigations were carried out on the photochemistry of oxygen and hydrogen to accompany the measurement of the OH and 1.27-μ O_2 emissions. Hydrogen and atomic oxygen emissions were measured in a hydrogen auroral arc. The results of analysis on a decade of twilight sodium density measurements are presented. (auth) (USGRDR)

39925 (AD-705227) VARIATIONS IN 2.2 MHz IONOSPHERIC ECHO STRUCTURE CORRELATED WITH HIGH-POWER 4.5 MHz TRANSMISSIONS. Palatucci, G. J. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). 1 Apr 1970. Contract Nonr-656(35). 127p. CFSTI.

It has been shown experimentally that certain features of the ionospheric echo structure of 2.2 MHz pulses are correlated with the on-off time of a high-power pulse transmitter operated at 4.5 MHz. Photographic and electronic data are presented that show examples in which the h'(f) of the main echos changed by a few kilometers with a characteristic time in the order of 10 to 60 sec during the high-power transmissions. A number of photographic records are also presented that show the abrupt appearance of sporadic-E echoes during the high-power intervals. A theoretical investigation into the possible cause for these experimental results is given. (auth) (USGRDR)

39926 (APD-15) SATURATION AND FOCUSSING EFFECTS IN RADIO-STAR AND SATELLITE SCINTILLATIONS. Singleton, D. G. (Weapons Research Establishment, Salisbury (Australia)). Mar 1969. 36p. Dep. CFSTI (U. S. Sales Only).

The diffraction and refraction theories of radio-star and satellite scintillations are re-examined and successfully reconciled to produce a composite result. This result gives new emphasis to the importance of focusing and saturation effects in scintillation studies. The results are displayed as contours of equal scintillation index on a plot of the distance parameter $\lambda z/r_0^2$ versus the r.m.s. phase deviation produced by the irregularities φ_0. An approximate expression for the scintillation index, previously considered to be valid only for $\varphi_0 < 1$ radian, is shown to have wider application. In terms of this approximation, connections between a number of variables, which determine whether or not irregularities fall into the saturation and focusing regimes, are examined. These variables include electron density increment in the irregularities, their size and shape, azimuth and topocentric and magnetic zenith angles of the direction of propagation, observing frequency, and geomagnetic latitude of the point of observation. As the result of these findings, possible explanations are put forward for a number of outstanding problems in scintillation studies. (Australia)

39927 (ESRO-SP-38) SUBSTORM EVENTS. Proceedings of an ESRO Colloquium held in Kiruna, Sweden, 18-20 March 1969. Ortner, J.; Moore, A. F. (eds.) (European Space Research Organization, Paris (France)). Sep 1969. 144p. (CONF-690342).

Contributions by discussion leaders and participants concerning the following topics are presented: optical, magnetic, magnetic pulsation, vlf emission, absorption, auroral ionization drift and backscatter measurements on the ground; ballon measurements of electron precipitation; optical measurements with rockets; rocket and satellite measurements of electric fields and high latitude particle precipitation and Langmuir probe measurements. Early results obtained with the ESRO I/Aurorae satellite are discussed and details are given of the ESRO Geostationary Satellite project. Separate abstracts are prepared for each of the four individual conference papers. (auth) (Sweden)

For abstracts of individual papers see: 39928-39931.

39928 (ESRO-SP-38, pp 11-20) OUTLINE FOR FUTURE STUDIES OF MAGNETOSPHERIC SUBSTORMS. Akasofu, Syun-Ichi (Alaska Univ., College. Geophysical Inst.).

Successive magnetospheric substorms are a basic phenomenon during the main phase of magnetospheric storms and they also manifest themselves in auroral, x-ray, ionospheric, proton aurora, and polar magnetic substorms. From the distribution of the magnetic disturbance vectors over the Earth's surface a three-dimensional electric current system is discussed, and its relation to the electron and proton distributions in the magnetosphere is in-

vestigated. It is suggested that an outwardly directed electric field should exist in the evening sector and an inward electric field should exist in the morning sector. The storage and explosive release of energy and its conversion into substorm energy are discussed in detail and further investigation of the asymmetric proton belt is shown to be important. A closely spaced east–west chain of auroral stations linked to an analysis center is now required for further studies of the auroral electrojet. (auth) (Sweden)

39929 (ESRO-SP-38, pp 21-39) POLAR MAGNETIC SUBSTORMS. Hultqvist, B. (Kungliga Vetenskapsakademien, Kiruna (Sweden). Geofysiska Observatoriet).

IGY and satellite data show that an electric jet current flows westward along the auroral oval rather than along the auroral zone and produces a negative bay close to the auroral oval. Adasofu assumed that return currents were responsible for the positive bays observed on the evening side of the Earth, but recent satellite measurements support a two-cell current system. DP 1 and DP 2 equivalent current systems are described and discussed. In auroral zone latitudes giving rise to bays, flow is in the direction of elongated auroral forms but in the polar cap regions the currents flow 30 to 60° away from the auroral arc directions and more experiments are required to resolve this apparent discrepancy. Recently, field-aligned currents have been invoked to account for some auroral phenomena, and the effect of such currents on magnetosphere models is considered. The dynamics of polar magnetic substorms including breakup, westward traveling surges, and auroral oval dimensions are discussed in detail. The role of the southward component of the interplanetary field in DP 1 and DP 2 variations is also considered, as well as the magnetic effects in the magnetospheric tail that are associated with polar magnetic substorms. (auth) (Sweden)

39930 (ESRO-SP-38, pp 41-3) SUBSTORM ASPECTS OF MAGNETIC PULSATIONS. Gendrin, R. (Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux (France)).

Geomagnetic micropulsations were divided into types that depend on the geometrical size of the magnetosphere and are less sensitive to individual substorms, and types which are very much dependent on substorm activity. The time differences between two different phenomena at one station or the same kind of phenomena at widely separated stations are investigated. Further studies over wide areas and correlated with satellite measurements are required. (auth) (Sweden)

39931 (ESRO-SP-38, pp 45-62) SUBSTORM ASPECTS OF AURORAL ABSORPTION AND OTHER EFFECTS OF THE UPPER PART OF THE AURORAL PARTICLE SPECTRUM. Jelly, Doris H. (Communications Research Centre, Ottawa (Ontario)).

Energetic electrons produce ionization in the 50- to 100-km region of the atmosphere that absorbs cosmic noise signals, as is shown by riometers. Auroral absorption averages and the average properties of individual substorms, particularly their longitudinal variations, are considered. In addition, the poleward and east–west apparent motions of events were analyzed, and absorption in all regions was found to be intimately connected. The phenomena known as "spikes" and "islands" are also discussed, as well as the location of the absorption during substorms relative to the energetic particle boundaries. (auth) (Sweden)

39932 POSSIBLE DETECTION OF ATMOSPHERIC GRAVITY WAVES GENERATED BY THE SOLAR ECLIPSE OF MARCH 7th 1970. Davis, M. J.; da Rosa, A. V. (Stanford Univ., Calif.). Nature (London); 226: 1123(20 Jun 1970).

It has been suggested that the cool shadow of the Moon, moving at supersonic speed across the atmosphere of the Earth during a solar eclipse, should generate gravity waves that would build up into a bow wave, and it has been estimated that a maximum pressure perturbation of 10^{-5} should occur at ground level and 10^{-1} at 200-km altitude. The high-altitude effect should produce a traveling-wave ionospheric disturbance. Studies are being made at Stanford of the columnar electron content of the ionosphere by measuring the Faraday rotation of the vhf transmissions from the geostationary satellites ATS-I and III, and observations are described for the eclipse conditions of March 7th 1970. The fluctuations in electron content observed along the Stanford to satellite paths are shown graphically; the observed undulations constituted a well-isolated event occurring at about the time the gravity wave was expected. The two trains of oscillations, although strongly correlated, were not entirely similar. Estimates of the time shifts between similar features observed at a number of stations allowed the horizontal phase velocity of the disturbances to be determined; the values obtained were about 620 ± 120 m/sec. The amplitude of the undulations was about $\pm 10^{16}$ electrons/m^2, and the background electron content amounted to about 60×10^{16} electrons/m^2, the relative magnitude of the undulations being of the order of 1.5%. The results implied a possible confirmation of the Moon shadow hypothesis. (UK)

39933 ECLIPSE OBSERVATIONS AT ARECIBO, PUERTO RICO, ON MARCH 7th 1970. Carlson, H. C. (Rice Univ., Houston, Tex.); Harper, R.; Wickwar, V.; Showen, R. L.; Behnke, R.; Trast, T. F.; Cogger, L. R.; Nelson, C. J. Nature (London); 226: 1124-5(20 Jun 1970).

Some observations are described using the incoherent backscatter technique, employing two modes, the first combining plasma-line and single-pulse autocorrelation data, and the second using double pulse techniques for improved altitude resolution in the bottomside ionosphere. The eclipse reached a maximum of about 30%, with a semiduration of about 80 min, at Arecibo. Profiles of electron density, electron temperature, and ion temperature are shown, as obtained in the plasma line mode. There were no striking temperature effects. The plasma line intensities contain information regarding the photoelectron flux, but showed no significant change during the eclipse. Estimates of the electron-to-ion energy transfer rate give 10,000, 6,766 and 10,230 (±15%) eV/cm^3/sec for the pre-eclipse, mid-eclipse and post-eclipse periods, respectively, at 300 km; and 4,900 3,340 and 6,600, respectively, at 260 km. This represents a decreased heat input to the electrons in the bottomside altitude range of about 30% during mid-eclipse, matching the percentage of totality. The heat conduction downward through the 550-km level throughout the eclipse was consistent with $1.8 \pm 0.3 \times 10^9$ eV/cm^2/sec, and the conduction downward through 600 km was decreased at mid-eclipse by an amount that seemed statistically significant, but could be explained by the increased topside electron density and consequent electron-to-ion loss rate at this time. The bottomside electron density profile decreased from the pre-eclipse to the post-eclipse period by an amount appropriate to the change in solar zenith angle, and the bottomside mid-eclipse electron density was substantially lower near the E region, as expected from recombination effects. The topside electron density at mid-eclipse was substantially increased. It has been suggested that atmospheric gravity waves might be generated by a solar eclipse, and contour plots of constant backscatter power revealed a weak wave-like disturbance. The question of whether these waves are associated with the eclipse needs to be considered within the context of data from other stations. (UK)

39934 PENETRATION OF SOLAR PROTONS INTO THE MAGNETOSPHERE AND MAGNETOTAIL. Lanzerotti, L. J. (Bell Telephone Labs., Murray Hill, N. J.); Montgomery, M. D.; Singer, S. J. Geophys. Res.; 75: 3729-34(1 Jul 1970).

Three sets of satellite measurements are used to compare solar proton fluxes in the magnetotail, in the outer magnetosphere, at synchronous altitude, and in interplanetary space. Comparisons of the interplanetary and magnetosphere proton fluxes show that outer magnetosphere disturbances play a strong role in the initial access of near-90° pitch-angle protons to synchronous altitude. One comparison of the magnetotail and synchronous altitude fluxes suggests that the synchronous altitude fluxes may not always result from a scattering of the protons in from the tail. The interplanetary magnetotail proton comparisons further confirm the results of Montgomery and Singer (1969), who found that delays in the proton access to the magnetotail were always present. (auth)

39935 OGO 5 OBSERVATIONS OF QUASI-TRAPPED ELECTROMAGNETIC WAVES IN THE SOLAR WIND. Scarf, F. L. (TRW Systems Group, Redondo Beach, Calif.); Fredricks, R. W.; Green, I. M.; Neugebauer, M. J. Geophys. Res.; 75: 3735-50(1 Jul 1970).

On April 5, 1968, a flare-associated sudden commencement was detected as OGO 5 was outbound through the bow shock region. Several hours later exceptionally high densities ($N_e > 70/cm^3$) were encountered, and, when the flux decreased by a moderate factor, large-amplitude 70-kHz noise bursts were sporadically detected on the vlf electric and magnetic sensors. The oscillations are interpreted with correlated E and B components as electromagnetic waves that have $n^2 \simeq 1 - \omega_p^2/\omega^2 < 1$, and direct comparison with the plasma probe density estimate gives an absolute calibration for that instrument. The measured wave amplitudes are also used to evaluate the local density from the relation $n = cB/E$, thus leading to an absolute calibration for the electric dipole within the streaming plasma. It is found that all measured or deduced densities are in agreement and are compatible with the interpretation that the correlated noise bursts represent electromagnetic waves with ω near the local plasma resonance frequency. These observations are related to previous measurements of 20- to 30-kHz electric fields in the solar wind (Zond 3, Venus 2, Pioneer 8 and 9, and Luna 11 and 12), and the problem of distinguish-

ing between electromagnetic waves of this type and electrostatic plasma oscillations is considered. (auth)

39936 OGO 5 OBSERVATIONS OF ELECTROSTATIC TURBULENCE IN BOW SHOCK MAGNETIC STRUCTURES. Fredricks, R. W. (TRW Systems Group, Redondo Beach, Calif.); Crook, G. M.; Kennel, C. F.; Green, I. M.; Scarf, F. L.; Coleman, P. J.; Russell, C. T. J. Geophys. Res.; 75: 3751-68(1 Jul 1970).

Data are presented on magnetic field, vlf electric field, and directed positive ion flux measurements made during passage of OGO 5 through many bow shock structures both inbound and outbound on March 12, 1968. These shocks were chosen because the period March 11–13, 1968, was one of a reasonably quiet solar wind. The data are correlated on time scales ≥144 msec and show that electrostatic wave turbulence is generated in the shock front by diamagnetic currents flowing on scale lengths $\sim c/\omega_{p-}$, the electron inertial length. This electrostatic turbulence builds to high levels near or in the regions of large jumps in |B| and then decays rapidly downstream. A jump in |B| and the scattering of randomization of protons are observed to occur only after a strong level of electrostatic turbulence is achieved; this leads to the conclusion that the electrostatic turbulence is a major contributor to the shock dissipative process. This turbulence is best explained as the ion acoustic or Buneman mode due to two-stream instability. One very thick shock structure is displayed which contains many very large amplitude and nearly reversible magnetic field pulsations. (auth)

39937 MARINER 5 MEASUREMENT OF THE EARTH'S LYMAN ALPHA EMISSION. Wallace, L. (Kitt Peak National Observatory, Tucson, Ariz.); Barth, Charles A.; Pearce, Jeffrey B.; Kelly, Kenneth K.; Anderson, Donald E. Jr.; Fastie, William G. J. Geophys. Res.; 75: 3769-77(1 Jul 1970).

The Lyman α emission originating from hydrogen atoms in the outer atmosphere of the Earth was measured between geocentric distances of 13,000 and 102,000 km. Since the radiative transfer effects are negligible, the observed emission rates are directly proportional to atomic hydrogen column densities. The observations are consistent with simple evaporative exospheric models, but there is a suggestion that some mechanism may be reducing the density of the satellite particles at distances greater than 50,000 km. (auth)

39938 MAGNETOSPHERE INFLATION DURING FOUR MAGNETIC STORMS IN 1965. Cahill, Laurence J. Jr. (Univ. of New Hampshire, Durham). J. Geophys. Res.; 75: 3778-88(1 Jul 1970).

Study of four magnetic storms in 1965, using Explorer 26 and ground observatory magnetic data, shows that both small and large magnetic storms develop through initial asymmetric inflation of the evening magnetosphere. Development times vary from 6 to 36 hours, and the development is sometimes interrupted. The inflating particles are injected as deep as L = 3 during the development phase in large storms but only to L = 4 in smaller storms. In the slow recovery phase, there is a clear relation between the magnitude of the inflation and the location of the inflation belt. The April storm belt with 100-γ inflation at the beginning of slow recovery was at L = 3.7, whereas the February storm with 30-γ inflation was at L = 4.8. An unusual distortion of field direction on June 16 is interpreted as evidence for current flow along field lines at the onset of a substorm. (auth)

39939 LOW-FREQUENCY DRIFT INSTABILITIES OF THE RING CURRENT BELT. Liu, Chuan Sheng (Univ. of California, Los Angeles). Contract W-7405-eng-48. J. Geophys. Res.; 75: 3789-3801(1 Jul 1970).

The stability of the ring current belt against low-frequency electrostatic perturbations is analyzed, including the effect of the finite electric field along the magnetic lines of force. The conditions for two purely growing instabilities, the interchange and the drift model are derived. For an isothermal plasma in a dipole field, the critical density gradients for the interchange and the drift mode are d ln n/d ln r = −7.5 and −1.5, respectively. Due to the parallel electric field associated with the instabilities, their main consequence is to precipitate charged particles into the ionosphere, thereby relaxing the pressure gradient of the ring current. (auth)

39940 ACCELERATION AND PRECIPITATION OF VAN ALLEN OUTER-ZONE ENERGETIC ELECTRONS. Parks, George K. (Univ. of Minnesota, Minneapolis). J. Geophys. Res.; 75: 3802-16(1 Jul 1970).

The first part of the paper presents the experimental results of a particle correlation experiment conducted between the magnetosphere and the auroral zone. The precipitation time profiles and increases of outer zone energetic electron fluxes are extremely well correlated. The enhancement of electron fluxes observed at synchronous altitudes is predominantly in the 50- to 150-keV energies. The increases are nonadiabatic, because they are not correlated with $\delta B/\delta t$. The variations observed in higher-energy electron fluxes are generally correlated with variations in the local magnetic field and hence can be accounted for by adiabatic theories. Energy spectrums of the equatorial- and auroral-zone electrons are similar, with typical e-folding energies of about 20 keV for both regions. Lifetimes of the nonadiabatic electrons are typically 10^3 sec but may be as short as ~200 sec. The equatorial electron pitch-angle distribution is anisotropic and peaked toward 90°. The anisotropy in the pitch-angle distribution changes with time and shows dependence on the electron flux. Finally, the energy spectrum in the equatorial plane is pitch-angle-dependent, with a steeper spectrum for smaller pitch-angle particles. The second part of the paper presents theoretical interpretations of the experimental results, which can be consistently interpreted in terms of local acceleration by using the strong pitch-angle-diffusion model. (auth)

39941 COMPARISON OF HYDROMAGNETIC WAVE PROPAGATION IN MAGNETOSPHERES OF PLANE AND CYLINDRICAL GEOMETRIES. Jenkins, Alvin W. Jr. (North Carolina State Univ., Raleigh). J. Geophys. Res.; 75: 3817-24(1 Jul 1970).

Two model magnetospheres are considered: one is a plane-layered medium over a plane-conducting earth, and one is composed of concentric cylindrical shells surrounding a conducting cylindrical Earth. The transmission coefficient for the amplitude of the magnetic field of an incident plane hydromagnetic wave is computed as a function of frequency for both models, and the results are compared. The scattering and diffraction effects present in the model with curved surfaces substantially reduce the transmission coefficient at higher frequencies. Also, differences in geometric shape are much more significant than any reasonable variation of other magnetospheric parameters within either model. (auth)

39942 WHISTLER EVIDENCE OF LARGE-SCALE ELECTRON-DENSITY IRREGULARITIES IN THE PLASMASPHERE. Park, C. G.; Carpenter, D. L. (Stanford Univ., Calif.). J. Geophys. Res.; 75: 3825-36(1 Jul 1970).

Large-scale structure in electron density in the plasmasphere was identified from whistlers recorded at Eights, Antarctica, near sunspot minimum. The structures have dimensions of the order of an Earth radius at the equator. Examples of the structures include an outlying peak in equatorial electron concentration near L = 4, with peak-to-valley ratio of 2, and more than 3:1 variations in electron concentration within 30° in longitude. Once formed, the structures may be observed for several hours or more. Detailed information on the occurrence of the irregularities is not yet available, but it is believed that they tend to develop under the influence of magnetospheric convection events. The convection events tend to accentuate departure from "smoothness" that originally developed through the action of ionosphere–protonosphere coupling processes and possibly through a cycle of erosion and accretion of plasma at the plasmasphere boundary in the dusk sector. (auth)

39943 WHISTLER EVIDENCE OF THE DYNAMIC BEHAVIOR OF THE DUSKSIDE BULGE IN THE PLASMASPHERE. Carpenter, D. L. (Stanford Univ., Calif.). J. Geophys. Res.; 75: 3837-47(1 Jul 1970).

Approximately 180 days of whistler data for 1963 and 1965 from Eights and Byrd, Antarctica, were reviewed for information on the bulge in the plasmasphere, the region of large plasmapause radius that is frequently found in the 18 to 21 LT sector. Previous findings on the essential permanance of the bulge and the abruptness of its westward end (involving an increase in plasmapause radius of 0 to 2.5 R_E within 15 to 20° longitude) were verified. The position in local time of the westward end of the bulge depends on the preceding history of substorm activity as evidenced in the auroral electrojet (AE) index. The bulge position was observed in the afternoon during particularly high levels of substorm activity, near 18 LT during more or less steady activity, and near 19 to 20 LT during periods preceded by 6 to 8 hours of quieting. The bulge is evidently released during periods of deep prolonged quieting and moves in the direction of the Earth's rotation. The observations are interpreted in terms of Sunward surges of the bulge during substorms, followed by increased influence of the Earth's corotation field during quieting. Several types of whistlers evidence indicate shielding of the dayside plasmasphere from substorm convection fields. The plasmapause is not generally coincident with an equipotential of the combined magnetospheric flow, but it may approach an equipotential during relatively steady planetary conditions. Under such conditions the dayside radius of the plasmapause may provide a crude time-averaged measure

of the stagnation distance and hence the intensity of the convection electric field in the dusk sector. Values of convection E_{YSM} within the duskside plasmasphere, inferred from the stagnation distance and from motions of the bulge, are ~1 to 4 mV/m during substorms, about 0.4 to 0.6 mV/m between substorms (but during moderate magnetic storms) and of order 0.1 mV/m during prolonged quiet periods. These values are larger by a factor of 3 to 4 than values of E_{YSM} inferred from tracking cross-L drifts of whistler ducts in the plasmasphere near midnight. (auth)

39944 MORPHOLOGY OF THE BULGE REGION OF THE PLASMASPHERE. Chappell, C. R.; Harris, K. K.; Sharp, G. W. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). J. Geophys. Res.; 75: 3848-61(1 Jul 1970).

The concentration of H^+ ions as a function of L was measured by the ion mass spectrometer on OGO 5. The data of June through November 1968 are presented. These data cover the local time region from 1400 to 2200 LT, which encompasses the bulge region of the plasmasphere. H^+ ion density versus L profiles show that the plasmapause position in this bulge region is located between approximately L = 4 and 9 and is generally found at increasingly larger L values as the magnetic activity decreases. In almost all cases, the density profiles through the bulge region exhibit a $1/R^4$ dependence with radial distance and have a steep density gradient at the outer edge of the bulge. The plasmasphere is observed to fill itself out to large L values during quiet magnetic periods and to have its plasma peeled away from its outer parts during times of moderate to high activity. One aspect of this peeling process is the occasional apparent detachment and sunward movement of a portion of the bulge region. A very extensive depletion of plasma is seen to accompany large magnetic storms. During unsteady and moderate to high magnetic activity periods, the bulge profiles usually contain large fluctuations in density at or immediately outside the plasmapause. Many characteristics of the observed profiles are consistent with the profiles predicted by using a magnetospheric convection model, which treats the bulge region as part of the main flow pattern of the plasmasphere. In this model the changes in the plasmasphere profiles and boundaries are dependent on a modulation of the convection electric field across the magnetospheric tail. (auth)

39945 TROPICAL ULTRAVIOLET NIGHTGLOW FROM OXYGEN ION–ION NEUTRALIZATION. Kmdsen, William C. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). J. Geophys. Res.; 75: 3862-6(1 Jul 1970).

The reaction $O^- + O^+ \rightarrow O(^5S \text{ or } ^3S) + O(^3P) + KE$ may be responsible for the recently observed tropical ultraviolet nightglow composed principally of the 1304- and 1356-A lines of atomic oxygen. The O^- concentration needed to obtain the observed emission intensity is less than 10^{-3} of the electron concentration. Emission intensity from this reaction in a steady state is controlled by the production rate of O^- which, in turn, is probably controlled by the height-integrated product of atomic oxygen and electron concentration. The quiescent intensity of the uv emission computed for this mechanism is of the order of 100 rayleighs. Some of the consequences of the mechanism are outlined and are compared with the consequences of a radiative recombination mechanism. (auth)

39946 OGO 4 OBSERVATIONS OF ION COMPOSITION AND TEMPERATURES IN THE TOPSIDE IONOSPHERE. Chandra, S.; Troy, B. E.; Jr.; Donley, J. L.; Bourdeau, R. E. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 75: 3867-78(1 Jul 1970).

Direct measurement of the densities of ionic constituents (H^+, He^+, and O^+) and the temperatures of ions and electrons were obtained from the Ogo 4 planar retarding potential analyzer in the altitude range 400 to 900 km. Results are presented from day and night passes in the middle and low latitudes near the 1967 fall equinox. The passes are selected to emphasize the latitudinal rather than the height dependence of the measurements. The main results can be summarized as follows: (1) Above 800 km at night, there is a deep equatorial trough in He^+ and a corresponding rise in O^+, suggesting a charge exchange between He^+ and O as an important loss mechanism for He^+. (2) The dominant ion in the night at these altitudes between ±40° geomagnetic latitudes is H^+ followed generally by O^+ and He^+. Outside this latitude region O^+ becomes the dominant constituent, increasing continuously toward the pole. (3) The major ionic constituent in the daytime is O^+ throughout the altitude and latitude range of observations. In the height range 400 to 500 km, the latitudinal variation in O^+ shows the well-known feature of the geomagnetic anomaly. (4) Both electron and ion temperatures generally increase poleward from their low-latitude values, attaining maxima between 40 and 50° geomagnetic latitude. (auth)

39947 TYPE II IRREGULARITIES IN THE EQUATORIAL ELECTROJET. Rogister, A.; D'Angelo, N. (European Space Research Organization, Frascati, Italy). J. Geophys. Res.; 75: 3879-87(1 Jul 1970).

An attempt is made to explain the type-II irregularities observed by Balsley in the equatorial E region. Vertical gradients in the plasma density appear to be essential for the excitation of the instability responsible for the irregularities. An interesting by-product of the calculations is that the Farley instability is recovered by making use of a fluid picture for both ion and electron components. (auth)

39948 ROCKET MEASUREMENT OF THE EQUATORIAL ELECTROJET. Shuman, B. M. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res.; 75: 3889-3901(1 Jul 1970).

Four Nike–Apache rockets, equipped with cesium vapor magnetometers, were launched in the equatorial electrojet region in March 1965. The rocket launched at the magnetic equator during the period of maximum electrojet current flow detected a 220-γ discontinuity in the magnetic field between 96 and 130 km. A peak current density of 13.5 amp/km^2 at 106 km was inferred from the data. A second rocket launched at the magnetic equator at night could detect no evidence, within a resolution of 5 γ, of any ionospheric currents. The remaining two rockets were fired at positions straddling the magnetic equator, where the local dip angle was approximately +5° and −5°. The observed magnetic field discontinuities indicate a north–south asymmetry in the equatorial electrojet, fitting a wide-current model to the north of the dip equator, and a narrow one to the south. (auth)

39949 THEORY OF NITRIC OXIDE IN THE EARTH'S ATMOSPHERE. Norton, Richard B. (ESSA Research Labs., Boulder, Colo.); Barth, Charles A. J. Geophys. Res.; 75: 3903-9(1 Jul 1970).

The chemical reaction $N(^2D) + O_2 \rightarrow NO + O$ can explain the observed NO density in the lower thermosphere, provided that a sufficient fraction of the atomic nitrogen is produced in the metastable ^2D state. The principal reactions energetically capable of producing $N(^2D)$ in the lower thermosphere are dissociative recombination $NO^+ + e \rightarrow N + O$ and the ion-atom reaction $N_2^+ + O \rightarrow NO^+ N$. To obtain the best overall altitude profile of NO density, 70 to 85% of the N produced by dissociative recombination and only a small percentage of the N produced by the atom-ion reaction must be in the ^2D state. (auth)

39950 LATITUDE PROFILES OF LOW-ENERGY SOLAR ELECTRONS. McDiarmid, I. B.; Burrows, J. R. (National Research Council of Canada, Ottawa). J. Geophys. Res.; 75: 3910-14(1 Jul 1970).

Preliminary latitude profiles were made of low-energy (E > 35 keV) solar electrons over the polar cap. The position of the latitude knee for these particles was determined and compared with corresponding measurements for solar protons (1 to 8 MeV) and with the location of the high-latitude boundary of 35-keV outer-zone electrons. It was found that the latitude knee for solar electrons lies 5 to 8° above the knee for solar protons and that the location of the electron knee agrees approximately with the 35-keV outer-zone boundary. (auth)

39951 IMPULSIVE PRECIPITATION EVENTS DURING AN AURORAL BREAKUP. Bernstein, W.; Wax, R. L. (TRW Systems, Redondo Beach, Calif.). J. Geophys. Res.; 75: 3915-18 (1 Jul 1970).

Large fluxes (10^9 cm^{-2} sec^{-1} ster^{-1}) of low-energy (1 to 10 keV) protons are precipitated together with comparable electron fluxes during the breakup and post-breakup phases of the aurora. Some rocket observations of abrupt impulsive increases in the precipitated 0.3- to 10-keV proton flux are reported here. Proton increases are associated with apparently equally abrupt decreases in the precipitated 0.2- to 6-keV electron flux. On April 17, 1969, the Nike–Tomahawk rocket was launched from Fort Churchill into an active coronal rayed form some 3 min after the magnetic field had reached a maximum depression of 150 γ. The breakup had begun, and by the end of the flight, the aurora was much diminished. The peak 5577-A intensity observed from the ground during the flight was ~14 kR. A PCA event occurred some 5½ days before the flight, and possibly a second event occurred 4 days before the flight. On the day of the flight there was a slight indication of the PCA, and it is felt that the data reported were not influenced by any solar cosmic rays. (J.C.W.)

39952 EFFECT OF WINDSHEAR ON THE NIGHTTIME E REGION AND AN ESTIMATE OF THE RATE OF PRODUCTION OF MOLECULAR IONS. Whitehead, J. D. (Univ. of Toronto). J. Geophys. Res.; 75: 3919-20(1 Jul 1970).

Vertical motion of the molecular ions in the nighttime E region, induced by horizontal neutral winds, will have a marked effect on

the molecular ion (and electron) distribution. This should be taken into account if the nighttime production of ionization is to be estimated from measured values of electron density. An estimate of a production of 3 molecular ions cm^{-3} sec^{-1} is found; it is about 0.1% of the daytime production. A specially designed rocket experiment could provide a better estimate. (auth)

39953 ELECTRIC FIELD IN THE MAGNETOSPHERE AS DEDUCED FROM ASYMMETRIES IN THE TRAPPED PARTICLE FLUX. Roederer, Juan G. (Univ. of Denver); Hones, Edward W. Jr. J. Geophys. Res.; 75: 3923-6(1 Jul 1970).

Available information on the magnetospheric electric field configuration represents isolated measurements at given points and given instants of time. Permanent local-time asymmetries of the flux distribution of stably trapped, low-energy particles were studied, using data from earlier measurements by two Geiger counters aboard Explorer 14. One instrument was sensitive to electrons of energy >40 keV and the other, sensitive to >230 keV. The data covered the period, October 1962 to August 1963. It was assumed that Explorer particles nearly follow equatorial particle drift traces. The procedure is given for testing a given electric field model. (J.C.W.)

39954 MAGNETIC FLUCTUATIONS DURING MAGNETOSPHERIC SUBSTORMS. I. EXPANSION PHASE. McPherron, Robert L.; Coleman, Paul J. Jr. (Univ. of California, Los Angeles). J. Geophys. Res.; 75: 3927-31(1 Jul 1970).

The ATS 1 observations of large-amplitude irregular fluctuations in the magnetic field at 6.6 R_E during the expansion phase of magnetospheric substorms are described. The fluctuations are predominantly in the H component, sometimes attaining amplitudes as large as 20 γ peak to peak. The spectra are steep, with no significant peaks. Examples of magnetic fluctuations associated with magnetospheric substorms were observed on March 3, 1967. The fluctuations are very irregular, with no apparent period. (J.C.W.)

39955 O I 4368-A EMISSION FOLLOWING EVENING TWILIGHT. Tinsley, Brian A. (Univ. of Texas, Dallas). J. Geophys. Res.; 75: 3932-4(1 Jul 1970).

Hanson suggested that radiative recombination of O^+ occurs in the F-region ionosphere at a sufficient rate to account for the O I 1304- and 1356-A emission observed near the intertropical ionization peaks. A ground-based search for an associated visible region transition from a midlatitude station was begun for the O I 4368-A line. Observations were made on January 28, 1970, near Langmuir Laboratory, New Mexico, at 60° zenith distance. The ionosonde at White Sands was not operating concurrently with the observations on January 28, but during further observations on March 6 and 7, 1970, the ionosonde was operating and gave further proof of the emission. (J.C.W.)

39956 UPPER LIMIT FOR THE RATE OF DESTRUCTION OF $O_2(^1\Delta_g)$ BY ATOMIC HYDROGEN. Brown, Robert L. (National Bureau of Standards, Washington, D. C.). J. Geophys. Res.; 75: 3935-6(1 Jul 1970).

An experiment was performed to study the effects of water on the production of O atoms by a microwave discharge using EPR to detect the discharge products O, $O_2(^3\Sigma_g^-)$, $O_2(^1\Delta_g)$, and H. From this experiment, an upper limit for the rate of destruction of $O_2(^1\Delta_g)$ by H atoms is derived. The apparatus is described. An upper limit for a quenching of $O_2(^1\Delta_g)$ by H in which H is not destroyed can be estimated. (J.C.W.)

39957 EDDY-DIFFUSION COEFFICIENTS DUE TO INSTABILITIES IN INTERNAL GRAVITY WAVES. Hines, C. O. (Univ. of Toronto). J. Geophys. Res.; 75: 3937-9(1 Jul 1970).

A new mathematical solution for the determination of the maximum effective diffusion coefficient that might be produced by turbulence from plane internal atmospheric waves is given for approximations of the wave frequency. Previously, a solution was given by Hodges (NSA 23: 42050) for an atmospheric scale height H = 5.5 km, for a range of horizontal and vertical wavelengths $10 \leq \lambda_x \leq 1000$ km and $6 \leq \lambda_z \leq 20$ km, respectively. Justification of the new mathematical solution is presented. (J.C.W.)

39958 TEMPORAL AND SPATIAL COVARIATION OF HIGH-LATITUDE GEOPHYSICAL PHENOMENA. Prasad, R. Y.; Singh, R. N. (Banaras Hindu Univ., India). J. Phys., A (London); 3: 400-3(Jul 1970).

A possible mechanism for the unification of regular and irregular fluctuations in high-latitude geophysical phenomena was given. In view of this mechanism the simultaneity of various geophysical fluctuations is discussed. (auth) (UK)

39959 DIURNAL VARIATIONS OF THE IONIC COMPOSITION AND PARAMETERS OF PROCESSES IN THE LOWER PART OF THE F REGION. Kosheiev, V. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 795-9 (1969).

Translated from Geomagn. Aeron.; 9: 987-92(1969).

A system of four continuity equations was simulated numerically for electrons and three kinds of molecular ions. The parameters of the basic chemical processes and changes of the ionic composition with time at heights of 140 to 200 km during the day were obtained from the initial data of N(t) profiles. The magnitude of the effective recombination coefficient at these heights was estimated. The absolute concentrations of ions for different months were found. (auth)

39960 THEORY OF NIGHTTIME RECOMBINATION IN THE UPPER IONOSPHERE. Fel'ske, D. Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 800-6(1969).

Translated from Geomagn. Aeron.; 9: 993-1001(1969).

The differential equation for nighttime recombination in the F region is reduced to a form convenient for integration and solved on a digital computer. The results are compared with experimental data. The most important parameter in this problem is the total electron content, N_{tot}, whose temporal variations are given. The computation model does not allow for the influence of the drift of the neutral gas on electron concentration. (auth)

39961 DEPENDENCE OF THE LOSS COEFFICIENT IN THE F2 REGION OF THE IONOSPHERE AND OF THE TEMPERATURE OF THE THERMOSPHERE ON THE DEGREE OF GEOMAGNETIC DISTURBANCE. Fatkullin, M. N.; Legen'ka, A. D. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 807-12 (1969).

Translated from Geomagn. Aeron.; 9: 1002-8(1969).

The scale height of the loss rate $H\beta$ in the F2 region was calculated for various conditions of geomagnetic activity by using $n_e(h,t)$ profiles. The calculations pertain to midnight conditions and are based on a continuity equation for an electron gas in which, in addition to the recombination term, the term due to motions is taken into account. The temperature of the thermosphere for various conditions of magnetic activity is estimated from $H\beta$. (auth)

39962 SIMULATION OF IONOSPHERIC CONDITIONS IN THE LOWER PART OF THE F REGION OF THE EQUATORIAL IONOSPHERE. Goncharov, L. P.; Kosheiev, V. V.; Shchepkin, L. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 813-16(1969).

Translated from Geomagn. Aeron.; 9: 1009-12(1969).

Results are reported on numerical simulation on an analog computer of a system of continuity equations for electrons and molecular ions, describing ionospheric conditions at heights between 140 and 200 km in the vicinity of the magnetic equator. The weighted mean coefficients of dissociative recombination and ion–molecule reactions are obtained, as well as the concentrations of atomic and molecular ions. The variations of their relative and absolute values with height and the time of the day are discussed. (auth)

39963 STRUCTURE OF THE NOCTURNAL POLAR ATMOSPHERE AND IONOSPHERE. Mirtov, B. A. Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 817-23(1969).

Translated from Geomagn. Aeron.; 9: 1013-21(1969).

A method is proposed for calculating a model of the nocturnal polar atmosphere and ionosphere at heights of 140 to 250 km. The initial parameters used are $[N_2] = \varphi(h)$, $[O_2] = \varphi'(h)$ and the profile of the electron concentrations. In addition, some values of chemical reaction constants are used. An example of the calculation of a specific model of the nocturnal polar atmosphere and ionosphere is discussed. (auth)

39964 INTERPRETATION OF IONOSPHERIC MOVEMENTS. Rybin, V. V. Geomagn. Aeron. (USSR) (Engl. Transl.) 9: 824-7(1969).

Translated from Geomagn. Aeron.; 9: 1022-6(1969).

The rate of replacement of charged particles by particles from the external plasma in ionized inhomogeneities moving in the ionosphere is examined. For inhomogeneities elongated along the magnetic field it was found that transverse movement at heights of ~90 to 130 km must be regarded as a movement of the form. Beyond this height interval, the inhomogeneities move approximately as a whole with their component particles. (auth)

39965 THEORY OF SUNRISE EFFECTS IN THE LOWER IONOSPHERE BASED ON MEASUREMENTS OF LONG-WAVE ABSORPTION. Kume, G. A.; Knut, R.; Wagner, Ch. U. Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 828-33(1969).

Translated from Geomagn. Aeron.; 9: 1027-34(1969).

The results of measurements of the absorption of long waves at middle latitudes before and during sunrise are reported. To determine the summer profile of the electron concentration for average sunspot (Wolf) numbers, which agrees with the increase of absorption due to the photodisintegration of the O_2 ion, use is made of the classical aeronomical model of the lower ionosphere. Absorption in the ionosphere with the calculated N(h) profile is determined. The computed N(h) profile adequately conveys the observed values of the increase in absorption at negative solar heights. The calculations indicate, however, that the classical model should be altered. (auth)

39966 HORIZONTAL IONOSPHERIC DRIFTS DURING LOW SOLAR ACTIVITY. Kazimirovskii, E. S. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 839-45 (1969).

Translated from Geomagn. Aeron.; 9: 1041-7(1969).

The results of an analysis of measurements of horizontal ionospheric drifts at Northern Hemisphere stations between 1960 and 1965 are reported. It is shown that the main patterns of the space–time distribution of the drift parameters have changed insignificantly compared with the IQSY. Meridional transport has intensified slightly and there are somewhat greater seasonal differences in the latitudinal variations of regular drift in the upper ionosphere. (auth)

39967 EMISSIONS OF HYDROGEN AND HELIUM IN THE UPPER ATMOSPHERE. Shefov, N. N. (Inst. of Atmospheric Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 846-9(1969).

Translated from Geomagn. Aeron.; 9: 1048-52(1969).

The behavior of emissions of hydrogen and helium is discussed. The most significant characteristics include a reinforcement of the hydrogen and helium emissions in the direction of the geomagnetic poles and reinforcement of the helium emission in the winter hemisphere. Mechanisms of excitation of the emissions are presented. (auth)

39968 GAMMA-ACTIVE SOURCE IN THE GEOMAGNETIC FIELD. Medvedev, Yu. A.; Stepanov, B. M.; Fedorovich, G. V. Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 869-71(1969).

Translated from Geomagn. Aeron.; 9: 1074-6(1969).

The effect of an isotropic gamma-active source in air of constant density was studied, disregarding the influence of the electric field of the Earth and the inhomogeneity of the geomagnetic field. The geomagnetic field intensifies when the source is actuated, and this fact was ascribed to the movement of the front of disturbing currents at the speed of light. It is shown that the magnetic field also intensifies in the vicinity of a stationary source of γ radiation. (J.C.W.)

39969 DISTURBANCE OF THE ELECTRIC AND MAGNETIC FIELDS AT GREAT DISTANCES BEHIND A BODY MOVING IN A COLLISIONLESS MAGNETIZED PLASMA. Vas'kov, V. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 871-2(1969).

Translated from Geomagn. Aeron.; 9: 1077-8(1969).

The electric and magnetic fields forming in the disturbed region behind a body at distances $r > \rho H a_0$ from it are estimated. The term ρH is the Larmor radius of ions and a_0 is the ratio of the velocity of the body to the thermal velocity of ions. (J.C.W.)

39970 SPECTRAL COMPOSITION OF IONOSPHERIC DISTURBANCES. Ben'kova, N. P.; Bukin, G. V.; Perekhvatov, Yu. K.; Testu, G.; Faynot, G. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Centre National d'Etude des Telecommunication, France). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 876-7(1969).

Translated from Geomagn. Aeron.; 9: 1082-3(1969).

F2-layer disturbances range from ionospheric storms during which the structure of the entire layer is totally disturbed to low-amplitude and short-lived electron density fluctuations. Spectra of the electron density fluctuations were analyzed, and a determination made of their morphological characteristics. The N(h) profiles for the observational data were computed for September 27 and October 4, 1967, the diurnal variations for heights 200 to 290 km were found, and an harmonic analysis of $N(h_i)$ to 8th order terms was performed. (J.C.W.)

39971 POSITIVE IONOSPHERIC DISTURBANCES AT MIDDLE LATITUDES. Khocholava, G. M.; Gachechiladze, R. G.; Nebagushvili, N. N. (Inst. of Geophysics, Tbilisi, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 878-9(1969).

Translated from Geomagn. Aeron.; 9: 1084-5(1969).

Disturbance in the F2 layer at middle latitudes was investigated on the basis of data from vertical ionospheric sounding stations during periods of minimum solar activity. Data for the analyses included f_0F2 data from Moscow during 1952 to 1954 and 1963 to 1965, years of solar activity minima. Also, observational data from the ionospheric stations Wakkanai, Akita, Kokubunji, and Yamagawa were used for the investigation. An analysis of the f_0F2 graphs showed that positive deviations sometimes occur at all four stations and sometimes at fewer stations. The probability that the phenomena will coincide at two, three, and four stations is approximately 74, 22, and 4%, respectively. (J.C.W.)

39972 DIRECTION AND SPEED OF IONIZED FORMATIONS IN THE F REGION. Vasil'ev, K. N.; Givishvili, G. V.; Vasherkin, V. A.; Leshchenko, L. N.; Modenova, V. S. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 880-1(1969).

Translated from Geomagn. Aeron.; 9: 1086-7(1969).

Observations were made to determine the speed and direction of plasma drift in the F region of the ionsphere. The formations have vertical and horizontal components and move northeasterly in winter and southeasterly in summer. The same ionosondes with the same delta antennas were used at three observation points triangularly spaced 67.5, 68, and 86 km apart. Observations were made between August and November, 1967. It is concluded that the horizontal dimension of vertically traveling ionospheric disturbances can be about 70 km. The prevailing horizontal direction of these movements is to the east at a speed of 80 to 100 m/sec. (J.C.W.)

39973 ANALYTICAL DESCRIPTION OF THE GLOBAL DISTRIBUTION OF E_s-LAYER PARAMETERS. Chernyshev, O. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 884-7(1969).

Translated from Geomagn. Aeron.; 9: 1091-4(1969).

A method for the analytical representation of the spatial variations of E_s-layer parameters is described. The description of latitudinal and longitudinal variations of parameters was performed in two stages. Available data from spherical analysis of the geomagnetic field for the 1955 epoch were used to compute the coordinates for all ionospheric stations and to construct a global map. (J.C.W.)

39974 DEPENDENCE OF THE CHARACTERISTICS OF A SPORADIC-E LAYER OF THE EQUATORIAL TYPE ON SOLAR ACTIVITY. Pogrebnoi, V. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 887-8(1969).

Translated from Geomagn. Aeron.; 9: 1095-6(1969).

Data from stations Trivandrum, Kodaikanal, Tiruchirapalli, Huancayo, and Ibadan were used to study the dependence of the characteristics of a layer of the sporadic-E type on solar activity. These stations operated during the IGY and IQSY. The average hourly f_0E_{sq} values and the monthly median f_0E_{sq} values for the noon hours were computed and then averaged for 12 months to exclude seasonal variations. A clear dependence of f_0E_{sq} on relative sunspot number is noted, and several characteristics of this dependence are discussed. (J.C.W.)

39975 FORMATION OF A SPORADIC-E LAYER DURING EDDY MOTIONS OF A GAS. Ignat'ev, Yu. A. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 888-90 (1969).

Translated from Geomagn. Aeron.; 9: 1096-8(1969).

The influence of wind eddies on the redistribution of electron concentration in the E region of the ionosphere was studied. Theories of the formation of the sporadic E layer are reviewed and mathematical equations are presented to help prove that the wind shear theory of Gershman and the author (Geomag. Aeron., 7: 1107(1967)) applies only to part of an eddy where wind velocity is nearly horizontal. (J.C.W.)

39976 DYNAMIC CHARACTERISTICS AND STRUCTURE OF THE SPORADIC-E LAYER DURING AURORAS. Zherebtsov, G. A.; Kurilov, V. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 891-2(1969).

Translated from Geomagn. Aeron.; 9: 1099-1100(1969).

Determinations of f_0E_s, f_bE_s, f_{min}, and $h'E_s$ for various types of sporadic-E layers and their variations during aurorae were made. The results of continuous ionospheric soundings from October 1966 to April 1967 during aurorae at Noril'sk were analyzed. The total time of combined ionospheric and visual auroral observations was ~100 hours. (J.C.W.)

39977 COSMIC-NOISE ABSORPTION. Kochenova, N. A.; Fligel, M. D. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 893-4(1969).

Translated from Geomagn. Aeron.; 9: 1101-2(1969).

A modified method for analyzing cosmic-noise records is given. The possible variations in cosmic-noise intensity at frequencies of 25 to 30 MHz at night, when f_0F_2 is minimal and does not exceed 5 to 6 MHz at middle latitudes, are estimated. The estimates of the various scattering mechanisms and the computed absorption values for possible models of the neutral and ionized atmosphere suggest that at night when $f_0F_2 \lesssim 6$ to 7 MHz, cosmic-noise absorption at a frequency of 25 to 30 MHz cannot change by more than 0.1 to 0.2 dB. (J.C.W.)

39978 ANOMALOUSLY HIGH RADIO-WAVE ABSORPTION IN 1960. Shirmammedov, M. (Inst. of Terrestrial and Atmospheric Physics, Ashkhabad, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 895-6(1969).

Translated from Geomagn. Aeron.; 9: 1103-4(1969).

The relationship between solar-activity variations, radio-wave absorption in the ionosphere, and the geomagnetic field disturbance was investigated. Data on radio-wave absorption in the ionosphere obtained at Ashkhabad between 1954 and 1964 by vertical sounding were used. The change in the intensity of the coronal 5303-Å line (for 90, 40, and 0° heliographic latitude) from 1954 to 1962 was used as the criterion of solar activity. From the data it is concluded that variations in radio-wave absorption in the ionosphere and also in geomagnetic field disturbance agree well with variations in the intensity of the coronal 5303-Å line, in the frequency of chromospheric flares, and with the double-peaked variation of solar activity in the 11-year cycle. (J.C.W.)

39979 VARIATIONS IN ELECTRON CONCENTRATION DURING VERTICALLY TRAVELING DISTURBANCES. Ryss, I. K.; Chernysheva, S. P.; Sharadze, Z. S.; Sheftel, V. M. (Rostov State Univ., Rostov-on-Don, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 896-7(1969).

Translated from Geomagn. Aeron.; 9: 1105-6(1969).

An attempt was made to apply the method of computing N(h) profiles to ionograms during vertically traveling disturbances (VTD) and to trace the variation in electron concentration at different fixed levels. The development of the VTD and the state of the ionosphere may be analyzed from these data. (J.C.W.)

39980 GEOMAGNETIC STORM FAMILIES BETWEEN 1957 AND 1964. V. CHARACTER OF THE DEVELOPMENT OF ACTIVITY WITHIN THE STORM FAMILIES. Afanas'eva, V. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 906-7(1969).

Translated from Geomagn. Aeron.; 9: 1116-17(1969).

A classification method is presented according to the character of the development of activity in geomagnetic storm families between 1957 and 1964. Categories include families with gradual, symmetric development of activity; sudden commencement of the development of activity; sudden termination of activity; and single families. A pattern in the distribution of families of any category was not found within a year. (J.C.W.)

39981 MAGNETIC ACTIVITY IN THE ANTARCTIC DURING THE IQSY. Afonina, R. G.; Zhigalov, L. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Arctic and Antarctic Scientific Research Inst., Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 907-10(1969).

Translated from Geomagn. Aeron.; 9: 1117-19(1969).

Earlier, one of the authors (Zhigalov) investigated the space–time patterns of magnetic activity in the Antarctic during the IGY (Magnetic Disturbances in the Antarctic; Gidrometeoizdat, 1967). Observations during the IQSY made it possible to perform a corresponding analysis for a year of minimum solar activity. The index $r_H\gamma$ served to estimate the intensity of magnetic activity. Data from 13 stations at high latitudes in the Southern Hemisphere were used in the analysis, and results are presented in this brief communication. (J.C.W.)

39982 SPATIAL DISTRIBUTION OF GEOMAGNETIC PULSATIONS. Kiselev, B. V.; Kovtun, A. A.; Kopytenko, Yu. A.; Petrova, A. A.; Raspopov, O. M. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 913-15(1969).

Translated from Geomagn. Aeron.; 9: 1124-6(1969).

The amplitudes of Pc3, Pc4, and Pi2 pulsations and their polarization on the meridional profile were analyzed from data recorded in 1964. The behavior of the amplitudes of Pc3 pulsations along the meridional profile revealed the presence of a region of maximum amplitudes, confined to $\Phi \sim 60°$. The region of maximum Pi2 amplitudes is north of $\Phi = 63°$. The amplitude maximum of Pc4 pulsations can be located both north of $\Phi = 63°$ and south of it, ~60°. The variation in the ratio of amplitudes and direction of polarization of Pc3 and Pc4 pulsations from station to station indicates that the source of these pulsations is local. Voelker found earlier that the periods of Pc3 and Pc4 pulsations increase with increasing latitude of the observation point; this study shows that the periods of Pc3 and Pc4 pulsations remain generally the same upon transition from middle to high latitudes. (J.C.W.)

39983 POLARIZATION OF GEOMAGNETIC PULSATIONS OF THE Pi2 TYPE. Van'yan, L. L.; Kiziriya, L. V.; Levitin, A. E.; Knizhnikova, L. A. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 916-17(1969).

Translated from Geomagn. Aeron.; 9: 1127-8(1969).

Eight pulsation trains recorded in November 1966 were analyzed. Records were made in the same latitudinal belt at Sogra, Podkamennaya Tunguska, Yakutsk, and Magadan. Hodographs were constructed. The same rotation of the magnetic field vector and the good correlation of Pi2 pulsations at a distance of more than 100° in longitude suggest a single source for this type of pulsation. If it is assumed that pulsation trains are the consequence of hydromagnetic waves directed by closed geomagnetic lines of force, then it must be assumed that the dimension of the source is $\sim 5 \times 10^4$km at a geocentric distance L = 10. Another interesting feature noted is the regular direction of the major axes of ellipses of Pi2 pulsations (direction of polarization). (J.C.W.)

39984 LATITUDINAL DEPENDENCE OF THE PERIOD AND AMPLITUDE OF STABLE Pc3-4 PULSATIONS. Baranskii, L. N.; Bol'shakova, O. V.; Geller, L. A.; Kazak, B. N. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 917-18(1969).

Translated from Geomagn. Aeron.; 9: 1128-9(1969).

Highly sensitive recording made it possible to determine the ratio of pulsation amplitudes at various latitudes for different groups of periods. In all the cases analyzed the amplitude increased with latitude for Pc3 and Pc4. This increase differed for pulsations of different periods. The amplitude for Pc4 increased by a factor of 1.4 in the latitude interval $\Delta\Phi = 30°$; for Pc4 it increased by a factor of 6. These data, obtained from individual comparisons, agree well with the results of a statistical estimate of the ratio of Pc3 and Pc4 amplitudes, obtained from a comparison of records of the H component of geomagnetic field variations in approximately the same interval of latitudes ($\Delta\Phi = 62$ to 44°). There is some discrepancy in the dependence of the Pc4 period and amplitude on latitude. In most cases the Pc4 period does not change with latitude; the Pc4 amplitude increases in all cases in approximately the same degree as the amplitude of Pc5 pulsations. (J.C.W.)

39985 MICROPULSATIONS WITH PERIODS OF 4 TO 12 SECONDS. Rokityanskaya, D. A. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 918-20(1969).

Translated from Geomagn. Aeron.; 9: 1130-1(1969).

Micropulsations of the Pc2 type with periods T = 5 to 10 sec were analyzed on the basis of records from the middle-latitude station Borok for 1957 through 1963 and Heiss Island for 1960 and 1961. It was found that between Pc1 and Pc2 there is an intermediate subgroup of pulsations with T = 4 to 6 sec, termed Pc1′, whose properties differ from those of Pc1 and Pc2. The periods, outer appearance, duration, probability of appearance in the solar activity cycle, the jump in amplitudes upon transition from Pc1′ to Pc2, and the different dependence of the micropulsations on magnetic field disturbance suggest a different origin of Pc2 and Pc1′. (J.C.W.)

Low-Temperature Physics

Refer also to abstracts 39647 and 40186.

39986 (ITF-70-36) ON THE QUANTUM STATISTICS HAMILTONIANS AND ON THE MODEL HAMILTONIANS OF THE THEORY OF THE SUPERCONDUCTIVITY. Petrina, D. Ya. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 27p. Dep. CFSTI (U. S. Sales Only).

The general hamiltonian of quantum statistics and the model hamiltonian of the theory of superconductivity at infinite volume are investigated. A rigorous mathematical meaning is given to the hamiltonians as the operators in the Hilbert space of sequences of translationally invariant functions. The general hamiltonian is not symmetric but it has a real spectrum. The model hamiltonian is symmetric and its spectrum has a gap between the energy of the ground and the excited states. (auth)

39987 (LA-tr-70-9) ENERGY STORAGE IN A SUPERCONDUCTING WINDING. Ferrier, M. Translated for Los Alamos Scientific Lab., N. Mex., from Bull. Inst. Int. Froid, Annexe; No. 1, 425-32(1969). 11p. Dep. CFSTI.

The problems of energy storage on the scale of the fluctuations

of the national or regional load, i.e., of the order of 1,000 MWh are examined. Various configurations are reviewed, and the short solenoid of circular cross section is selected as being economically the most favorable. The field produced and the distribution of the mechanical constraints are discussed for this configuration. An examination of the various losses (at the surface of the cryostat, by mechanical or magnetic hysteresis) shows that they are acceptable. The circulation of the cryogenic fluid is discussed in detail, and it is shown that it can be maintained by natural convection; it is also shown that the ratio of stabilizing material to superconducting material can be reduced to 10:1. Finally, the modes of connecting the storage device to the grid are examined and there is a discussion of the optimum size of the installation as a function of the financial benefits that can be attributed to the different services provided by the device. (auth)

39988 (LA-tr-70-11) STUDY AND CONSTRUCTION OF AN ENERGY-STORING SUPERCONDUCTING COIL. Girard, B.; Sauzade, M. Translated for Los Alamos Scientific Lab., N. Mex., from Bull. Inst. Int. Froid, Annexe; No. 1, 419-23(1969). 6p. Dep. CFSTI.

A superconducting coil used to store energy and restore it in about one millisecond is described. Specially studied is the problem of current interruption. The coil was made from Nb–Ti stranded cable stabilized with pure aluminum. Its maximum energy content is approximately equal to 20 kJ and it is closely coupled with an aluminum ribbon coil that takes the place of the secondary coil of a non-iron transformer. The superconducting winding has ten times as many turns as the secondary winding. In this way it is possible to discharge the stored energy at a lower impedance (less than 1Ω) or at a higher impedance (about 10Ω) by connecting the load to the secondary or the superconducting circuit. The current is rapidly discharged by opening the circuit via a vacuum switch using an artificial zero-current injection system. This switch can break 1,000 A, without failure, with overvoltages of 4000 or 5000 V. It is capable of withstanding even higher voltages. The switching time is only a few microseconds. The stabilized superconducting coil withstood many charge rates of a few tenth of seconds duration and discharge rates of 3 or 4 milliseconds. Transfer energy rating is about 65%. At the moment, a part of the coil energy is being lost through induced currents being dissipated through the metal walls of the cryostat. (auth)

39989 (LNF-70/10) INTRODUCTORY NOTES ON THE STABILIZATION OF SUPERCONDUCTING MATERIALS. Note No. 468. Ricci, M. V. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 26 Feb 1970. 19p. Dep. CFSTI (U. S. Sales Only).

These notes were taken from lectures given at the International School of Applied Physics on "Development of Applied Superconductivity," Erice, April 1969. The following subjects are covered: degradation, stabilization, complete stabilization, partial stabilization, minimum propagating current, and other methods of stabilization. (M.H.R.)

39990 (SLAC-Trans-119) LOSSES IN TYPE-II SUPERCONDUCTORS THROUGH DISPLACEMENT OF VORTICES. Baixeras, J.; Fournet, G. Translated by R. Addis for Stanford Linear Accelerator Center, Calif., from Phys. Lett.; 20: 226-8(1966). 5p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 19738.

39991 (SLAC-Trans-120) LOSSES THROUGH VORTEX DISPLACEMENT IN A NONIDEAL TYPE-II SUPERCONDUCTOR. Baixeras, J.; Fournet, G. Translated by R. Addis for Stanford Linear Accelerator Center, Calif., from J. Phys. Chem. Solids; 28: 1541-7(1967). 17p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 43975.

39992 (UCRL-19624) A STUDY OF THE SUPERCONDUCTIVITY OF METALS CONDENSED AT 4°K. Roberts, James Adams Jr. (California Univ., Berkeley. Lawrence Radiation Lab.). Jun 1970. Contract W-7405-eng-48. 37p. Dep. CFSTI.

The superconducting transition temperatures, T_c, of electron-beam-evaporated metals (Al, Sn, and Pb) condensed on liquid-helium-cooled substrates were measured. The T_c's of Al and Sn were increased above the bulk values to 3.1 and 5.09°K, respectively. The T_c of Pb remained unchanged. The metals were also co-condensed with xenon resulting in further increases for the T_c's of Al(3.7°K) and Sn(6.22°K) and a decrease for Pb. The effects of annealing on T_c and normal-state resistance were also measured. (auth)

39993 MAGNETOSTRICTION IN SUPERCONDUCTORS. II. EXPERIMENTS. Braendli, G. (Eidgenoessische Technische Hochschule, Zurich). Phys. Kondens. Mater.; 11: 111-38 (12 Apr 1970). (In German).

The magnetostriction is investigated in mono- and polycrystalline type-I and -II superconductors by a capacitance method. The field dependence of the magnetostriction is measured exactly and compared to the results of part I of this work. The agreement is good, particularly for the magnetostriction due to superconducting surface currents in the mixed state. The investigated materials are pure In and Pb and alloys of In–Pb, In–Tl, Pb–In and Ta–Nb in the form of spheres, ellipsoids, or rods. (auth)

39994 MAGNETOSTRICTION IN SUPERCONDUCTORS. I. CALCULATIONS. Braendli, G. (Eidgenoessische Technische Hochschule, Zurich). Phys. Kondens. Mater.; 11: 93-110(12 Apr 1970). (In German).

The magnetostriction in superconductors is calculated thermodynamically as completely as possible for samples of ellipsoidal form. In particular, the dependence of the magnetostriction on the external magnetic field is studied. When there is partial field penetration this contains terms that disappear again when superconductivity is completely destroyed. These are due to: (1) the influence of the Ginzburg–Landau parameter; (2) the magnetostriction due to surface supercurrents in the mixed state and in the state of surface superconductivity; and (3) the influence of the form of the specimen on the magnetostriction. (auth)

39995 THE TRANSIENT ANALYSIS OF COAXIAL CABLES AT LOW TEMPERATURE CONSIDERING ANOMALOUS AND CLASSICAL SKIN EFFECTS WITH THE INCLUSION OF ELECTRONIC RELAXATION PHENOMENA. Rathke, James Edward. Lawrence, Kan.; Univ. of Kansas (1969). 199p.

Thesis.

Low-temperature effects on the frequency-domain and time-domain step responses of coaxial cables are analyzed, considering classical and anomalous skin effect and electronic relaxation time as metallic loss mechanisms. Generalized transmission-line equations are developed that utilize frequency- and temperature-dependent dielectric functions and metallic-surface impedance data. Formulas are developed for the bounding frequencies of the classical skin effect, anomalous skin effect, and extreme relaxation regions. Also, a procedure for finding the frequency and step responses of a transmission line having a spatial temperature variation is developed. It is shown that some errors exist in the formulas given by R. B. Dingle (Physica, 19: 113(1953)) for finding the surface impedances of metals in the anomalous range, and a correction technique to reduce these errors is introduced. Surface impedance data on seven metals (Ag, Al, Au, Cu, Pb, Nb and Sn) are tabulated. Also presented are predicted frequency- and time-domain responses vs. temperature (4 to 300°K) of six commercial miniature coaxial cables. Furthermore, predicted responses are presented for a Nb–Pb superconductive coaxial cable maintained in the normal state; the effects of a spatial temperature distribution along the Nb–Pb lines are included. The results of the investigation generally show that, for TEM mode propagation, the upper frequency limitation and time-domain dispersion decrease with decreasing temperature. (Diss. Abstr. Int., B)

39996 MACROSCOPIC QUANTUM PHENOMENA. Vinen, W. F. (Univ. of Birmingham, Eng.). Riv. Nuovo Cim.; 1: Special No., 485-94(1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

Subjects covered are: the ordering process in a superfluid, the nature of superfluid flow, and the effect of thermal fluctuations in the order parameter. (M.H.R.)

39997 THERMAL EXPANSION OF LIQUID HELIUM II. Harris-Lowe, R. F.; Smee, K. A. (Royal Military Coll., Kingston, Ont.). Phys. Rev., A; 2: 158-68(Jul 1970).

The thermal-expansion coefficient of liquid helium II under its saturated vapor pressure was measured from 0.85 K to within 0.4 mK of the λ transition. The capacitive technique employed was well suited for these measurements. With the aid of the Clausius–Mossotti equation, a relative change in density of 1 part in 10^8 could be resolved in a manner free from sources of systematic error. The data below 1.60 K were analyzed to obtain information about the density derivatives of the Landau parameters Δ, p_0, and μ with the following results: $(\rho/\Delta)(\partial\Delta/\partial\rho) = -0.763 \pm 0.012$ and $\frac{1}{2}(\rho/\mu)(\partial\mu/\partial\rho) + 2(\rho/p_0)(\partial p_0/\partial\rho) + (\rho/\Delta)(\partial\Delta/\partial\rho) = -1.638 \pm 0.077$. The results of a reanalysis of the data obtained by other workers in this temperature interval are presented in order to provide a valid comparison with the present results. The techniques employed also allowed measurements to be taken to within 0.4 mK of the λ transition. At this temperature, the uncer-

tainty in an individual measurement (one standard deviation) had reached about ±10%. This represents a considerable improvement over previous measurements and allows a detailed examination of the validity of the Pippard–Buckingham–Fairbank relations. It was found that the agreement between theory and experiment is good if the temperature dependence of all the terms in these relations is taken into account. The capacitance bridge was also employed to measure absolute values of the dielectric constant of liquid helium at temperatures of approximately 1.0 K and a frequency of 5 kHz. Analysis of these measurements yielded a value for the molar polarizability of 0.123,296 ± 0.000,030 cm^3 $mole^{-1}$. (auth)

39998 MODEL FOR THE QUANTUM SCATTERING OF A ^{3}He IMPURITY FROM A RECTILINEAR VORTEX IN LIQUID He II. Titus, William J. (Stanford Univ., Calif. Univ. of Minnesota, Minneapolis). Phys. Rev., A; 2: 206-20(Jul 1970).

A model is given that describes the quantum scattering of a ^{3}He impurity from a rectilinear vortex in liquid He II; the principal assumption is the existence of an impurity wave function that satisfies a Schrödinger equation. Various possibilities for the impurity–vortex interaction are discussed. For certain interactions, the theoretical results are consistent with the experimental work of Rayfield and Reif provided spatial variations in the superfluid density are considered. A T-matrix formalism is also developed and applied to the vortex scattering of impurities, as well as phonons and rotons. The results are compared to existing theoretical and experimental work; the main discrepancies occur for roton scattering. (auth)

39999 EFFECT OF IMPURITIES ON THE FLOW STRESS CHANGE AT THE SUPERCONDUCTING–NORMAL TRANSITION. Buck, O.; Alers, G. A.; Tittmann, B. R. (North American Rockwell Corp., Thousand Oaks, Calif.). Scr. Met.; 4: 503-8(Jul 1970).

A lead single crystal of ¼ in. diameter and 2 in. gauge length was deformed in tension at 4.2°K. The impurity content compared to a crystal previously used is given. The change of flow stress $\Delta\tau$ was measured dynamically at three different strain rates to observe the effects of purity on the phenomenon. An additional experiment was also performed to see if $\Delta\tau$ could also be measured by a static stress-relaxation experiment. The observations lead to the speculation that the change of flow stress associated with the change of electronic state is an impurity effect and is associated with a change of pinning strength for the dislocation–impurity interactions. This change of the pinning strength could be caused by a change of the electronic contribution to the (mainly elastic) interaction energy of dislocations and impurities. (M.H.R.)

40000 ANGULAR ACCELERATION OF LIQUID HELIUM II. Chan, S. L. (Univ. of Malaya, Kuala Lumpur, Malaysia). Phys. Fluids; 13: 1903-12(Aug 1970).

Studies were made of the processes of angular acceleration and retardation of a simply connected volume of helium II at 1.64°K using the technique of second sound attenuation. The acceleration and retardation are found to approach closely to reversibility as compared with experiments where the acceleration is more rapid. A critical velocity for bringing helium II into rotation was found and the most reliable value for this is (0.047 ± 0.005) cm sec^{-1} for a cylindrical cavity of radius 2.60 cm. A relaxation time of about 10^3 sec is found for helium II to come into rotational equilibrium. Persistent currents of long lifetime were also seen. The results are interpreted in terms of quantized vortices in liquid helium II. (auth)

40001 DISLOCATION CELL STRUCTURE AND ANOMALOUS CRITICAL FIELDS FOR SUPERCONDUCTIVITY IN SEVERELY DEFORMED NIOBIUM. Hill, D. C.; Rose, R. M. (Massachusetts Inst. of Tech., Cambridge). Appl. Phys. Lett.; 17: 66-7(15 Jul 1970).

The dependence of the anisotropy of the resistive critical field of severely deformed Nb on plastic strain and temperature, the anomalously large stress dependence, and the existence of resistive transitions in fields up to 48 kG all confirm the role of the dislocation cell wall in giving rise to critical-field enhancement in this material. (auth)

40002 MODEL TO EXPLAIN LARGE CHANGES IN THE ELECTRONIC DENSITY OF STATES WITH ATOMIC ORDERING IN V_3Au. Labbe, J. (Univ. of Paris, Orsay, France); van Reuth, E. C. Phys. Rev. Lett.; 24: 1232-5(1 Jun 1970).

The superconducting transition temperature of V_3Au has been experimentally shown to vary by a factor of 300, depending on the degree of atomic ordering. This has previously been attributed to a change in the electronic density of states n(E) with ordering. A model is proposed here which provides a theoretical basis for this change in n(E) with ordering. (auth)

40003 MEASUREMENTS OF THE KAPITZA CONDUCTANCE BETWEEN METALS AND LIQUID HELIUM II BY THE TRANSMISSION OF SECOND SOUND. Challis, L. J.; Sherlock, R. A. (Univ. of Nottingham, Eng.). J. Phys., C (London); 3: 1193-1206(May 1970).

Measurements have been made in the temperature range 1.0 to 2.0 K of the alternating heat current transmitted through thin metal foils separating two second sound resonators. The experimental arrangement and analysis are described in some detail. The values of the Kapitza conductance obtained in this way of copper, and of indium, lead and tin, are comparable to those obtained using the usual steady state method, although the temperature dependence is always significantly higher: about T^4. In general, the total foil conductance in the superconducting state is larger than in the normal state and it is believed that this is due to size effects arising from the long phonon transmission coefficient from lead to helium is greater than or approximately equal to 0.67. (auth) (UK)

40004 THERMODYNAMIC FUNCTIONS OF INTERACTION IN QUANTUM LIQUIDS ^{4}He AND ^{3}He. Pudakov, E. S. (Inst. of Catalysis, Novosibirsk, USSR). Teor. Eksp. Khim.; 5: 216-25 (Mar-Apr 1969). (In Russian).

The application of the method of interaction functions to quantum liquids is discussed. The absolute values of the interaction energies at T = 0°K were found to be 14.3 in ^{4}He and 11.0 cal/mole in ^{3}He. The relation of the work of the interaction shutting-off system volume for the whole range of temperatures was established generally along the line of saturation. Areas of the interaction entropy anomaly were discovered in ^{4}He and ^{3}He, where the liquid appears less ordered in comparison with the ideal gas. It is possible to exclude these anomalies in the case of ^{3}He by calculation of the spin entropy, and for the case of ^{4}He by the differences of the concentrated component with zero entropy in liquid and Bose gas. (tr-auth)

40005 ELECTRICAL PROPERTIES AND SUPERCONDUCTIVITY OF RHENIUM AND MOLYBDENUM FILMS. Frieberthauser, P. E. (McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.); Notarys, H. A. J. Vac. Sci. Technol.; 7: 485-8 (Jul-Aug 1970).

Electrical and superconducting properties of rhenium and molybdenum films prepared by electron-beam evaporation were measured as a function of substrate temperature, film thickness, and substrate material. The films were prepared at residual pressures of 5×10^{-8} torr. In addition, films of each material were prepared by reactive deposition at nitrogen pressures in the 10^{-5} torr range. Rhenium films prepared at low residual pressures exhibited superconductivity with onset temperatures from 2.5 to 4.9°K depending on thickness and substrate temperature. However, rhenium films prepared by reactive deposition in nitrogen had onset temperatures from 4.6 to 5.5°K. Transition temperatures from 3.3 to 3.8 °K were observed in molybdenum films at thicknesses greater than 6000 Å when deposited at substrate temperatures of 600°C. Crystal structure and preferred orientation were determined by x-ray diffraction methods. (auth)

40006 CURRENT–VOLTAGE CHARACTERISTIC OF AN IRRADIATED SUPERCONDUCTING POINT CONTACT. Volkov, A. F.; Nad, F. Ya. (Inst. of Radio Engineering and Electronics, Moscow). JETP Lett. (USSR)(Engl. Transl.); 11: 56-9(20 Jan 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma REd.; 11: 92-7 (20 Jan 1970).

On the basis of a superconducting-contact model, the I(V) characteristic is calculated under irradiation, particularly near the step (vertical section), and the results are compared with experiment. It was found that V(I) is a single-valued function and therefore the form of the observed current–voltage characteristic is independent of the measurement conditions. (M.H.R.)

40007 INTERACTION OF SUPERCONDUCTING FLUX LINES WITH DISLOCATIONS. Nabarro, F. R. N.; Quintanilha, A. T. (Univ. of Witwatersrand, Johannesburg). Mater. Res. Bull.; 5: 669-80(Aug 1970).

The interaction between flux lines and a parallel array of dislocations is calculated, using a model in which the core of a flux line is in interaction with several dislocations simultaneously. Two interactions are considered, the linear interaction between the strain field of the dislocation network and the stress field of the core of the flux line, and the quadratic interaction between the strain field of the dislocation network and the increased elastic stiffness of the metal in the core of the flux line. Each interaction is considered in the unperturbed approximation, in which the contours of superconducting electron density in the core are unaltered by the interaction with the dislocation network, and the perturbed approximation, in which these contours are perturbed

by the interaction. The linear interaction always predominates over the quadratic. The unperturbed interaction predominates when $T < 0.9\ T_c$, and the perturbed when $0.9\ T_c < T < 0.99\ T_c$. The interaction between flux lines and dislocations is usually so strong that the rigidity of the flux line lattice can be neglected. At low dislocation densities, and below $0.9\ T_c$, the maximum trapped flux density is determined by the condition that this last statement should be true, and is proportional to $(1 - T/T_c)$. Under all other conditions pinning remains strong up to a flux density of almost H_{c2}, and the trapped flux has the temperature dependence of H_{c2}. (auth)

40008 SUPERCONDUCTIVITY VERSUS FERROELECTRICITY. Matthias, Bernd T. (Univ. of California, San Diego, La Jolla. Bell Telephone Labs., Murray Hill, N. J.). Mater. Res. Bull.: 5: 665-8(Aug 1970).

Experimentally, superconductivity and ferroelectricity seem to exclude each other. In organic materials, ferroelectricity is the dominant of the two phenomena. This conclusion is strengthened through a purely dimensional argument. (auth)

40009 MODEL FOR CRITICAL CURRENT AND MAGNETIZATION OF TYPE II SUPERCONDUCTORS IN LONGITUDINAL MAGNETIC FIELDS. Sugahara, Masanori (Yokohama National Univ., Japan). J. Appl. Phys.; 41: 3668-72(Aug 1970).

The flux-density distribution and its stability in the mixed state of type II superconductors in the presence of a stationary longitudinal magnetic field are considered in the connection with the critical conduction current and the longitudinal magnetization. It is believed that the theory simulates reasonably well the behavior of the superconductors. It is found that the flux pinning by imperfections in the superconductors becomes ineffective in the longitudinal field because of the induced helical vibrations of pinned flux lines. (auth)

40010 CRITICAL CURRENT STUDIES OF FLUX TRAPPING IN SUPERCONDUCTING LEAD. Leupold, H. A.; Winter, J. J.; Breslin, J. T. (Army Electronics Command, Fort Monmouth, N. J.). J. Appl. Phys.; 41: 3679-86(Aug 1970).

A convenient critical current method for observing the salient features of flux trapping in superconductors is used to study a variety of lead and lead-alloy samples. The critical fields H_1, H_a, H_c for type I and H_{c2} for type II superconductors are obtained and found to be in accord with the results of other investigators employing different techniques. Because of self-fields due to current asymmetries, the full critical currents of some samples are observed in nonzero applied fields H_{pl}. The critical current versus applied-magnetic-field characteristics of lead pressure contacts and their application to a simple magnetic null detector are discussed. It is found that trapping flux in certain solid specimens can cause a fourfold enhancement of the peak critical current. (auth)

40011 THEORETICAL BEHAVIOR OF TWISTED MULTICORE SUPERCONDUCTING WIRE IN A TIME-VARYING UNIFORM MAGNETIC FIELD. Morgan, G. H. (Brookhaven National Lab., Upton, N. Y.). J. Appl. Phys.; 41: 3673-9(Aug 1970).

A simplified model is used to study the response to a slowly changing uniform magnetic field of a wire consisting of fine filaments of superconductor embedded in a normal metal matrix, the entire wire being twisted about its axis. Expressions for the critical twist pitch, the power loss in the normal metal, and the time constant are obtained. (auth)

40012 SOME CONSIDERATIONS REGARDING THE APPLICATION OF A LINEAR CHAIN MODEL TO SOME COMPOUNDS OF THE β-W STRUCTURE. Weger, M. (Faculte des Sciences, Orsay, France). J. Phys. Chem. Solids; 31: 1621-39(Jul 1970).

In A_3B compounds possessing the A15 (β-W) lattice, such as V_3Si, "A" atoms are arranged in families of interpenetrating linear chains. As a consequence, the electronic band structure may display one-dimensional properties. A model lattice is considered by the tight-binding approximation, and it is shown that sections of the constant energy surfaces are approximately planes, and the wave functions are concentrated on chains perpendicular to these planes, even for quite strong interchain coupling. The symmetries of 3d states localized on atoms of a single chain are investigated, for the cubic and strained states of the lattice. It is shown that for some bands, the interchain coupling vanishes for $k = 0$; for these bands, it is conceivable that the density of states displays a sharp maximum there. It is also shown that due to the special symmetry of the lattice, a uniform uniaxial strain can open up a gap at the center of several of the bands of the linear chains, and this effect may also lead to a lattice instability. (auth) (UK)

40013 SUPERCONDUCTIVITY OF LANTHANUM AND CERIUM AT HIGH PRESSURES. Ratto, C. F. (Faculte des Sciences, Orsay, France); Coqblin, B.; d'Agliano, E. Galleani. Advan. Phys.; 18: 489-514(Sep 1969).

A theoretical model involving the presence of an inner 4f shell is developed to explain the pressure dependence of the superconducting transition temperature of lanthanum and the presence of a superconducting high-pressure phase of cerium. In this model, only the conduction electrons are assumed to participate in the superconductivity mechanism, while the 4f electrons tend to inhibit superconductivity. As the 4f character decreases with increasing pressure in lanthanum, it is possible to account for the anomalous pressure dependence of the superconducting transition temperature by assuming a valency a little less than three at normal pressure. The anomalous behavior of cerium, magnetic at room temperature and normal pressure and superconducting above 50 kbar, is also discussed. (auth) (UK)

40014 SUPERCONDUCTIVE PROPERTIES AND STRUCTURE OF VACUUM-DEPOSITED TIN FILMS. Hill, J. S.; Stoddart, C. T. H.; Stuart, P. R. (National Physical Lab., Teddington, Eng.). J. Phys., D (London); 3: 1168-78(Aug 1970).

The effect of oxygen, present during film formation, on the structure and superconducting properties of tin films vacuum deposited on glass was studied for substrate temperatures during deposition in the ranges of 23 to 30°C and 63 to 91°C. In both temperature ranges, in general, an increase in oxygen pressure decreased crystallite size and electron mean free path; it increased the superconducting critical magnetic field value and width of transition but decreased the superconducting temperature transition width. The higher substrate temperatures produced films with larger crystallites and thin intercrystalline regions; these showed hysteresis in the superconducting magnetic field transition and had higher values of critical field and critical current, in excess of those theoretically predicted. (auth) (UK)

40015 TRANSITIONS TO SUPERCONDUCTIVITY OF DISORDERED FILMS. Grassie, A. D. C.; Green, D. B. (Univ. of Sussex, Brighton, Eng.). J. Phys., C (London); 3: 1575-86(Jul 1970).

Measurements were made of the transitions to superconductivity of quench-condensed aluminum films at various stages of annealing. The films exhibit enhancement of the transition temperature and transition characteristics that are broader than may be accounted for by the theory of mean-field fluctuations alone. A model in which the transition broadening is attributed to a distribution of transition temperatures within the films is proposed, and the analysis is carried through to a calculation of transition characteristics. Despite broadening of the magnetic-field-induced transitions, it appears that disordered films are, nevertheless, well described by the Ginzburg–Landau theory. (auth) (UK)

40016 SPECIFIC HEAT, SUPERCONDUCTIVITY, AND CRYSTALLINE ORDER OF VANADIUM BASED ALLOYS WITH A15 STRUCTURE. Spitzli, P.; Fluekiger, R.; Heiniger, F.; Junod, A.; Muller, J.; Staudenmann, J. L. (Univ., Geneva). J. Phys. Chem. Solids: 31: 1531-7(Jul 1970).

The low-temperature specific heat and the superconducting transition temperature were measured in binary alloys of vanadium with Os, Ir, Pt, Au, Rh, Pd, Co, and Ni exhibiting the A15-type structure. The results show a remarkable correlation between the electronic specific heat and the rate of occupation of the chain sites in this structure by atoms of vanadium. (auth) (UK)

40017 PROPERTIES OF SUPERCONDUCTING POINT CONTACTS. Taguchi, Isao; Yoshioka, Hide (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 29: 371-9(Aug 1970).

The I–V characteristics of point contacts between superconductors have been studied for their dependence on the temperature, the magnetic field and the microwave power level. Structures which appeared in the I–V characteristics in the absence of microwave powers have been related to the enhanced superconductivity of a part of the contacts and the subharmonic tunneling effects. Most of the temperature dependence of the zero-voltage current can be explained by considering the spatial variation of the current density and introducing a "mean Josephson penetration depth." Microwave power dependence of the amplitude of induced steps disagrees with the Bessel function behavior. The discrepancy may be caused by the effect of the Josephson penetration depth. (auth)

40018 CONTROLLED PINNING IN SUPERCONDUCTING FOILS BY SURFACE MICROGROOVES. Morrison, D. D.; Rose, R. M. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 25: 356-9(10 Aug 1970).

To test the idea that surface irregularities can pin fluxons, regular parallel microgrooves were created in the surfaces of homogeneous cast In–2% Bi foils by pressing diffraction gratings into the foils. The pinning force thus induced was zero for flux flow parallel to the grooves and a maximum for perpendicular flux flow; a very simple dependence on the spacing and strength of the pinners was found. (auth)

40019 CRYSTALLOGRAPHIC STUDY OF THE LOW-TEMPERATURE PHASE TRANSFORMATION IN V_3Si AND Nb_3Sn. Wanagel, J.; Batterman, B. W. (Cornell Univ., Ithaca, N. Y.). J. Appl. Phys.; 41: 3610-15(Aug 1970).

The cubic–tetragonal phase transformation in V_3Si and Nb_3Sn has been investigated dynamically with optical and x-ray techniques. For Nb_3Sn a simple shear on the $\{110\}\langle 1\bar{1}0\rangle$ completely describes the lamellar morphology in the tetragonal state. The lamellar structure and associated shear are concluded to arise from an accommodation of internal stresses and are a result of, not a mechanism for, the transformation. All the observations are consistent with a continuous transformation from the cubic to tetragonal state with no evidence of hysteresis or the coexistence of the two phases. (auth)

40020 INDUCTANCE OF SUPERCONDUCTORS. Solymar, L.; Seraphim, G. R. S. (Oxford Univ.). Phys. Lett.; 32A: 212(27 Jul 1970).

It was pointed out by Wyatt [Phys. Lett., 29A: 353(1969)] that a superconductor may store energy in the form of the kinetic energy of superelectrons. He worked out the corresponding inductance with the aid of the Ginzburg–Landau theory and Josephson's phase slippage equation [Phys. Lett., 1: 251(1962)]. The same inductance may be derived by viewing the superconductor as a charged fluid where each superelectron has a charge 2e and a mass m. The equation of motion is $m(dv/dt) = 2e(E + v \times B)$ where E = electric field, v = particle velocity, and B = magnetic field. Assuming that the magnetic term on the right-hand side is small, changing from Lagrangian to Eulerian variables and neglecting the resulting quadratic term, eq. (1) modifies to: $m\delta v/\delta t = 2eE$. Assuming further that the electric field is uniform, it is related to the voltage by $El = V$ where l is the length of the superconducting specimen. Expressing the current in the form $I = 2envA$ (where n is the density of superelectrons and A is the cross section) and defining the inductance by the equation $V = LdI/dt$, we get $L = lm/4e^2nA$, in accordance with Wyatt. (Entire article)

40021 ACOUSTIC-SURFACE-WAVE ENERGY-GAP AND MIXED-STATE STUDY OF Pb FILMS. Jain, M. C.; MacKinnon, L. (Univ. of Essex, Eng.). Phys. Lett.; 32A: 275-6(27 Jul 1970).

The magnetic field dependence of the attenuation of 316-MHz acoustic surface waves is studied for both parallel and perpendicular fields in thin superconducting lead films. For the parallel field case, deduction of the pair potential field dependence shows agreement with an approximate theory. For the perpendicular field case, the attenuation varies near H_{c2} in the way theory predicts for bulk behavior in the dirty limit. (auth)

40022 THEORY OF STRUCTURE IN THE SUPERFLUID HELIUM SPECTRUM CONSIDERING ROTON–ROTON RESONANCES. Ruvalds, J.; Zawadowski, A. (Univ. of Virginia, Charlottesville). Phys. Rev. Lett.; 25: 333-7(10 Aug 1970).

Interactions between excitations in superfluid helium are investigated by Green's function techniques. In the model, a sharp peak appears in the two-excitation spectrum corresponding to a resonance of two rotons. Interaction of the resonance with the single-particle spectrum results in a hybridization and splitting of the one-particle spectrum into two distinct branches. These theoretical results are in agreement with recent neutron-scattering and Raman-scattering experiments. (auth)

40023 SOUND VELOCITY IN LIQUID HELIUM BELOW 0.6°K. Cheung, T. H. (Univ. of Toronto). Phys. Lett.; 32A: 211-2(27 Jul 1970).

Extending recent work of Wehner and Klein on ultrasonic attenuation in He II, the shift in the sound velocity due to the first 3-phonon vertex correction is computed. (auth)

40024 EVAPORATION FROM LIQUID HELIUM. Parry, W. E. (Oxford Univ.). Phys. Lett.; 32A: 227-8(27 Jul 1970).

Evaporation from liquid helium is discussed from a theoretical point of view. The model used is similar to that used for tunneling in superconductors: the system is formally split into three regions, the liquid, gas, and surface. The liquid region is assumed to be at a potential ϵ_0 lower than the gas and the surface is a narrow region at a rather high potential. This assumed external potential is really a mean field approximation for the interatomic potentials for the helium atoms. The Hamiltonian is then written as a sum of three parts, $H_{liquid} + H_{gas} + H_{transition}$, and conventional time-dependent perturbation theory is applied to H_T. The form of the transition operator H_T is discussed. (M.H.R.)

40025 TWO-FREQUENCY MULTIPOLE PROCESSES IN SUPERCONDUCTING TUNNEL JUNCTIONS. Hamilton, C. A.; Shapiro, S. (Univ. of Rochester, N. Y.). Phys. Lett.; 32A: 223-4(27 Jul 1970).

By exposing a superconducting tunnel junction to microwave radiation at two frequencies simultaneously, photonassisted tunneling steps corresponding to sum and difference frequencies have been observed. (auth)

40026 FLUCTUATIONS IN THE RESISTIVE TRANSITION IN ALUMINUM FILMS. PART I. PURITY DEPENDENCE. Kajimura, K.; Mikoshiba, N. (Electrotechnical Lab., Tokyo). Phys. Lett.; 32A: 216-17(27 Jul 1970).

Effects of sample purity on the excess conductivity of Al films were measured. The excess conductivity was strongly dependent on the electronic mean free path in contrast with the theory of Aslamazov and Larkin. (auth)

40027 TEMPERATURE DEPENDENCE OF THE REFLECTION COEFFICIENT OF ELECTRONS ON THE INTERFACE BETWEEN SUPERCONDUCTING AND NORMAL PHASES. Landau, I. L. (Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.); 11: 295-7(5 May 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 437-40(5 May 1970).

Experiments were performed on a cylindrical single crystal of indium with C_4 axis aligned with the sample axis. The cylinder diameter was 3 mm and the resistance ratio was $\rho(300°)/\rho(0°) = 4.65 \times 10^4$. The intermediate state was produced by a transverse magnetic field. The electric conductivity was measured by passing through the sample a current of $0.1\ I_c$. The potential difference was measured with a superconducting modulator. (M.H.R.)

40028 EXCHANGE INTERACTIONS AND SUPERCONDUCTIVITY OF LANTHANUM WITH RARE-EARTH IMPURITIES. Druzhinin, V. V.; Moskvin, A. S.; Karpovtsev, E. A. (Ural State Univ., USSR). Fiz. Metal. Metalloved.; 29: 915-23 (May 1970). (In Russian).

The s–f exchange with variations of the multiple f-shell is studied. The properties of operators changing their moment of motion are discussed. A Hamiltonian is obtained for exchange interactions of conducting electrons in the rare-earth ion (s–f–s exchange interactions). The drop in the critical temperature of superconducting lanthanum relating to the s–f–s exchange is analyzed, considering direct magnetic dipole interactions (spin of conducting electron and orbital moment of the f shell). Theoretical and experimental data for T_c of lanthanum with rare-earth impurities are correlated. (tr-auth)

40029 STUDIES OF THE STRUCTURE OF SUPERCONDUCTING ALLOY 65 BT. Buinov, N. N.; Vozilkin, V. A.; Rakin, V. G. (Inst. of Physics of Metals, Moscow). Fiz. Metal. Metalloved.; 29: 1005-9(May 1970). (In Russian).

X-ray analysis and electron microscopy were used for determining the structure of the superconducting alloy 65BT (containing Nb–Ti–Zr as main components). It is shown that, on heating at 300 to 800°C, the alloy decomposed with strong pulverization of a certain portion of the solid solution. Particles of ~0.1μ in the separating phases became the sources of dislocations. (tr-auth)

40030 POSITIVE ION MOBILITY IN ^3He–^4He MIXTURES. Bowley, R. M.; Lekner, J. (Cambridge Univ., Eng.). J. Phys., C (London); 3: L127-30(Jul 1970).

The motion of positive ions in ^3He–^4He mixtures is investigated in the region where the mobility is limited by ion–^3He scattering. The inclusion of a residual polarization interaction has a large effect, and, together with hard-core scattering, is sufficient to bring theory and experiment into qualitative agreement in the nondegenerate region. (auth) (UK)

40031 SYSTEM $Nb_3Sn_{1-x}Sb_x$ AND THE DENSITY OF STATES MODEL FOR Nb_3Sn. Vieland, L. J. (RCA Labs., Princeton, N. J.). J. Phys. Chem. Solids; 31: 1449-54(Jul 1970).

The temperature of the cubic–tetragonal transformation in Nb_3Sn and the magnitude of the tetragonal distortion were found by x-ray measurements to be independent of Sb doping over the range studied, $0 < x < 0.15$. However, the addition of a small amount of Sb resulted in a c/a ratio greater than unity, while for pure Nb_3Sn, $a > c$. These results are discussed in terms of the density of states model of the lattice transformation in β-tungsten superconductors. (auth) (UK)

Plasma and Thermonuclear Physics

Refer also to abstract 39737.

40032 (UPee-70/2) CURRENT STATE AND DIRECTION OF RESEARCH ON PLASMA IN ITALY. Gasparini, F. (Padua Univ. (Italy). Istituto di Elettrotecnica e di Elettronica). Feb 1970. 29p. (In Italian). (CONF-691044-1). Dep. CFSTI (U. S. Sales Only).

From 55th National Conference of the Italian Physics Society, Bari, Italy.

The more recent developments of Italian research in plasma physics, with respect to thermonuclear plasmas, magnetohydrodynamic conversion, quiescent plasmas, and the most significant results on practical applications, are given. (auth)

40033 FLOW EQUATIONS FOR COMPOSITE GASES. Burgers, J. M. Applied Mathematics and Mechanics. An International Series of Monographs. Volume 11. New York; Academic Press Inc. (1969). 345p. $18.50.

Topics treated include the Bhatnagar-Gross-Krook and Fokker-Planck approximations, charged particles in electric and magnetic fields, and the effects of chemical reactions and of radiation. Separate treatment of the left and right sides of the Boltzmann equation facilitates discussion of various collision problems, cross-section cutoff effect with two-particle distribution functions, the standard Maxwell-Boltzmann collision integral, and other topics. (M.O.W.)

40034 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. VOLUME 4, NO. 5, 1970. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 37p.

This listing includes 176 articles on plasma and controlled thermonuclear research. (M.O.W.)

40035 WORLD SURVEY OF MAJOR FACILITIES IN CONTROLLED FUSION. Nucl. Fusion; Spec. Suppl., 1-250(Jun 1970). (STI/PUB-23).

A list of the world's major thermonuclear facilities is given. A brief description and some major results of each experiment are given. (M.O.W.)

Confinement and Heating

Refer also to abstracts 40099 and 40122.

40036 (KHFTI-69/43) EFFECTIVENESS OF CURRENT HEATING IN A DENSE HIGH-CURRENT GAS DISCHARGE PLASMA. Manzyuk, N. A.; Suprunenko, V. A.; Sukhomlin, E. A.; Ternopol, A. M. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1969. 10p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The physical effectiveness of current heating of a dense high-current gas-discharge plasma stabilized by a strong magnetic field was studied. The heating effectiveness was about 60%. The current heating continued throughout the current flow in the active discharge region. The previously obtained value for the plasma heating coefficient ($\approx 3 \times 10^{12}$ eV/cm^3) was confirmed. (tr-auth)

40037 PLASMA CONFINEMENT IN A TOROIDAL THETA PINCH WITH SUPERPOSED HEXAPOLE FIELD. Meisel, Dieter (Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys.; 236: 362-72(1970). (In German).

The confinement of a plasma in a toroidal theta pinch with superposed hexapole field is investigated experimentally. The temperature and density of the plasma are measured with time and spatial resolution by means of laser scattering. The measured loss rates agree within 30% with the results of the cusp theory. (auth)

40038 POSSIBILITY THAT ANOMALOUS PLASMA DIFFUSION DEPENDS ON GEOMETRIC FACTOR. Yoshikawa, S. (Princeton Univ., N. J.). Contract AT(30-1)-1238. Phys. Rev. Lett.; 25: 353-6(10 Aug 1970).

Turbulent diffusion coefficients for an assumed spectrum are derived using fluid equations, a crucial assumption being that the ion motion parallel to the magnetic field is hindered by the collision of ions with neutrals. The result shows that the turbulent diffusion coefficients depend on geometric factors, as well as on the level of fluctuations. This dependence on geometric factors may explain the experimentally observed difference in confinement times in different toroidal plasma confinement devices. (auth)

Diagnostics

Refer also to abstract 39909.

40039 (AD-704822) DOUBLE-PROBES AND SCATTERING OF A LASER BEAM AS DIAGNOSTIC METHODS ON A PULSED HIGH-TEMPERATURE PLASMA. Final Technical Report (Part 5). Metz, Siegfried (Florida Univ., Gainesville. Dept. of Nuclear Engineering Sciences). 1 Jan 1970. Contract Nonr-580(19). 77p. CFSTI.

Increasing particle density and temperature can be observed during the decay of a pulsed, electrodeless discharge. Responsible for this effect are electrostatic waves excited by interactions of beams of charged particles with the decaying plasma. Under certain discharge conditions a convective instability occurs. Two diagnostic methods were employed to investigate this nonstationary high-temperature plasma. A double-probe technique based on sampling methods gave excellent time and spatially resolved results, although this method is rather complicated and only seldom employed in case of high-voltage discharges. Maximum discharge voltage is restricted to 35 kV. (auth) (USGRDR)

40040 (AD-705134) DIRECT MEASUREMENT OF THE MAINTENANCE VOLTAGE OF A THERMAL INDUCTION PLASMA. Eckert, Hans U. (Aerospace Corp., El Segundo, Calif.). 30 Jan 1970. Contract F04701-69-C-0066. 21p. (TR-66(9220-2)-6; SAMSO-TR-70-148). CFSTI.

The axial distribution of voltage induced near the inner wall of a 3.8-cm-diameter tube confining an rf argon induction plasma at atmospheric pressure was measured at a flow rate of 115 cm^3/sec with a watercooled ring probe. Also measured as functions of probe position were the excitation frequency, voltage, and current on the inductor coil. The plasma reduced the probe voltage to about 60% of its value in the absence of the plasma. After correction for the effects of cooling and displacement of the plasma by the probe, the total induced voltage around the circumference of the plasma at the midsection was found to be 64 V. The corresponding value for electric field intensity was 6 V/cm. This value falls between published values obtained by indirect methods and is in fair agreement with prediction on the basis of a one-dimensional theory. (auth) (USGRDR)

40041 (AD-705155) ANALYSIS OF THE VELOCITY FIELD IN PLASMAS FROM THE DOPPLER BROADENING OF SPECTRAL EMISSION LINES. Kaufman, Asher S. (Bar-Ilan Univ., Ramat-Gan (Israel). Dept. of Physics). Dec 1969. Contract F61052-68-C-0005. 93p. CFSTI.

A critical and systematic review of the analysis of the velocity field is presented, together with some original contributions. The source of radiant energy is taken to be a hot, optically thin plasma. The opening chapters are devoted to a discussion of the kinetic temperature and mass motion in a plasma, followed by a criterion of distinguishing between the two forms of motion. The experimental methods of separating thermal motion from random mass motion (named commotion) are then classified. The larger part of the paper is devoted to the method of separation called the method of different ionic species, in which the broadening of spectral lines from these species is measured. It is concluded that, in view of the severe restrictions placed on this method, it can only be used successfully in special cases rather than generally. (auth) (USGRDR)

40042 (IPPJ-T-5) QUADRUPOLE MASS FILTER AND ITS APPLICATION TO THE STUDY OF PLASMA. Okamoto, Yukio; Tamagawa, Hajime (Nagoya Univ. (Japan). Inst. of Plasma Physics). May 1970. 27p. Dep. CFSTI (U. S. Sales Only).

The characteristics of a mass spectrometer as an experimental means to study plasma ionic constituents are surveyed and evaluated. The considerations lead to the choice of a quadrupole mass filter as the most suitable type. The specification of the mass filter as well as its performance is described. The mass separation is performed by a high-frequency field without the use of a deflecting magnet. The mass filter is operated at a frequency of 2 MHz with a variable voltage for scanning between 1 and 100 amu with a resolution of approximately 100. The quadrupole poles are 30 cm in length. The technique described here makes possible more definitive information about the microscopic properties of plasma. (auth) (Japan)

40043 (LRP-40/70) MEASUREMENT OF IONIC TEMPERATURES IN A PINCH OF A ROTATING MAGNETIC FIELD. Berney, A. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Jun 1970. 83p. (In French). Dep. CFSTI (U. S. Sales Only).

Ion temperature measurements were made by means of Doppler line broadening in a rotating magnetic field pinch experiment. A 12-channel Fabry-Perot interferometer was constructed and profiles of various helium and impurity lines were measured as functions of time and position in the discharge tube. The theoretical standard deviation of the results was computed by a statistical analysis, using a Monte Carlo simulation program. This allowed

one to separate the real variations of the plasma from the fluctuations of the measurements. The main limitations of the accuracy of the results were due to lack of light intensity and parasitic broadening mechanisms (Stark and reabsorption effects). Nevertheless, reasonable values of the temperatures of ionized nitrogen, oxygen, and helium were obtained for three different filling pressures (20, 60, and 180 mtorr He). (auth)

40044 USE OF LASER LIGHT FOR INVESTIGATIONS OF ATOMS, MOLECULES, AND PLASMAS. Zwicker, H. (Institut fuer Plasmaphysik, Garching, Ger.). Riv. Nuovo Cim.; 1: Special No., 495-505(1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

The use of lasers as a physics research tool is discussed. The first use discussed is that of molecular spectroscopy by means of the Raman effect. Another use of laser light is the interaction with acoustic phonons. The dispersion, absorption, and scattering of a laser beam by a plasma are described for the purpose of plasma diagnostics. (M.O.W.)

40045 METHOD FOR INFRARED DIAGNOSTICS OF A PLASMA AND ITS APPLICATION FOR INVESTIGATION OF IONIZATION AND RECOMBINATION OF XENON BEHIND THE FRONT OF A SHOCK WAVE. Generalov, N. A.; Zimakov, V. P.; Kozlov, G. I. (Inst. of Mechanics Problems, Moscow). Zh. Eksp. Teor. Fiz.; 58: 1928-37(Jun 1970). (In Russian).

A method is described for determination of the electron temperature and electron concentration profiles behind the front of a shock wave. It is based on simultaneous measurement of emission and absorption by the ionized gas in the infrared region of the spectrum ($\lambda = 10.6\ \mu$). Results of an experimental investigation of ionization and recombination processes in xenon at T = 8200 to 9200°K are presented. Good agreement between the experimental data and recombination theory based on a modified Fokker–Planck theory is obtained. (auth)

40046 THEORY OF ELECTRIC PROBES IN DENSE PLASMA. Ul'yanov, K. N. Zh. Tekh. Fiz.; 40: 790-8(Apr 1970). (In Russian).

The theory of probes was formulated with consideration of ionization and recombination in plasma. Expressions were obtained for the ion current in dense cylindrical and spherical probes. It was found that, according to the ion current in the cylindrical and spherical probes, the concentration of the charged particles in the plasma could be determined, and according to the current on the plane probe, the recombination coefficient could be determined. The performance of the probe in nonstationary conditions is described. (tr-auth)

40047 METHOD OF STUDY OF LOCAL POTENTIAL AND DENSITY FLUCTUATIONS IN AN ALKALI METAL PLASMA. Cussenot, J. R.; Felden, M. (Laboratoire de Physique des Milieux Ionises, Nancy). Rev. Phys. Appl.; 4: 519-24(Dec 1969). (In French).

The fluctuating parameters of a plasma having oscillations of ion and electron density and local potential are studied, beginning with a knowledge of the perturbed and nonperturbed components of the current collected by a grid probe. After a brief theoretical analysis, the experiments made in a cesium plasma are discussed; there was good agreement between theoretical and experimental results. (tr-auth)

40048 SHEATH AT AN ELECTRODE CLOSE TO PLASMA POTENTIAL. Andrews, J. G.; Varey, R. H. (Central Electricity Generating Board, Southampton, Eng.). J. Phys., A (London); 3: 413-20(Jul 1970).

It is shown that a sheath with a monotonic potential profile can exist at all negative voltages on an electrode in a plasma. When the electrode is close to plasma potential it is no longer valid to ignore those electrons which reach the electrode. The velocities with which ions approach the sheath satisfy a "sheath criterion," which depends upon the potential drop across the sheath and not just on the electron temperature in the plasma. (UK)

40049 ION CURRENT FROM A COLLISION-DOMINATED FLOWING PLASMA TO A CYLINDRICAL ELECTRODE SURROUNDED BY A THIN SHEATH. Clements, R. M. (Univ. of Victoria, British Columbia); Smy, P. R. J. Appl. Phys.; 41: 3745-9(Aug 1970).

Experimental results for the ion current to a cylindrical electrode in a flowing continuum plasma are compared with the currents calculated from a convection-dependent thin-sheath theory obtained by extending the theory of Lam to cover convection rather than diffusion-generated currents. The relation derived with this theory $I_i \approx 5.3\epsilon_0^{1/2} e^{1/2} \mu_i^{1/2} r_p^{1/2} v_f^{1/2} n_\infty^{1/2} V^{1/4} l$, where ϵ_0 is the permittivity of free space, e is the electronic charge, μ_i is the ion mobility, r_p is the probe radius, v_f is the plasma/probe velocity, n_∞ is the ionization density, V is the probe bias, and l is the probe length, is found, on the average, to predict the experimental currents to within ±30% over ranges of 0.1–5 mm in probe radius, 5×10^2–4×10^3 cm/sec in probe/plasma velocity, 5×10^{16}–2×10^{18}/m^3 ionization density, and 10–100 V in probe bias. Further support for a convection-dependent thin-sheath model is provided by two experimental observations: (1) The current is observed to vary as $V^{1/4}$ as predicted by the convection-dependent theory rather than to saturate as would be expected of a diffusion-generated current. (2) Separate measurements reveal a marked asymmetry in the current distribution around the probe surface as expected in a thin-sheath situation. (auth)

40050 SPECTROSCOPIC MEASUREMENT OF THE FREQUENCY, INTENSITY, AND DIRECTION OF ELECTRIC FIELDS IN A BEAM–PLASMA INTERACTION BY THE HIGH-FREQUENCY STARK–ZEEMAN EFFECT. Cooper III, William S.; Hess, Roger A. (Univ. of California, Berkeley). Phys. Rev. Lett.; 25: 433-6(17 Aug 1970).

The Zeeman pattern of the "satellites" of spectral lines produced by the high-frequency Stark effect was used to determine the direction of an oscillating electric field relative to the magnetic field. The use of this effect was illustrated as a diagnostic technique in plasma physics by observations of the Zeeman pattern of the "plasma satellites" of the 4922-Å He-I line produced by high-frequency electric fields in a beam–plasma interaction. (auth)

40051 NOISE TEMPERATURE AS A MEASURE OF MEAN ELECTRON ENERGY IN A GASEOUS DISCHARGE. Messenger, R. A.; Van Der Ziel, A. (Univ. of Minnesota, Minneapolis). Physica; 47: 64-74(29 Apr 1970).

A technique thought to be more relevant and applicable than the conventional Langmuir-probe technique for determining mean electron energy in a gas discharge is presented here. Electron temperatures obtained using a Langmuir probe are compared with noise temperatures measured with external probes at high frequencies for a variety of discharge conditions. The results lead to a simple formula for finding mean electron energies using noise techniques. (auth)

40052 SMALL SIZE RETARDING FIELD ENERGY ANALYSER FOR LOCAL MEASUREMENT OF ELECTRONIC DISTRIBUTION FUNCTION IN A MAGNETOPLASMA. Bouchoule, A.; Weinfeld, M. (CNRS, Orsay, France). J. Phys., E (London); 3: 651-2(Aug 1970).

A small electron energy analyzer was built. It is a three-electrode retarding-field type electrostatic analyzer with an outside diameter of 2.0 mm and a length of 14 mm. It is self-orientating parallel to a dc axial magnetic field, and may be used to study electron energy distribution functions in a beam–plasma system. (auth) (UK)

40053 OPTICAL MEASUREMENT OF THE FLUCTUATION LEVEL IN A TURBULENT PLASMA. Hamada, Yasuji (Tokyo Univ.). J. Phys. Soc. Jap.; 29: 463-7(Aug 1970).

In a turbulent plasma heated by a strong electric field, the forbidden lines of He I $4^1F \rightarrow 2^1P$ and $4^3F \rightarrow 2^3D$ showed themselves as the satellite of allowed transition of He I $4^1D \rightarrow 2^1P$ and $4^3D \rightarrow 2^3P$ lines. The appearance of these satellites is due to the electric field of the waves in the turbulent plasma. In 1.0 μs after the electric field was switched on, the plasma was heated up to the energy density of 1×10^{15} eV/cm^3 and the satellite had shaded away. The energy density of the electric fields in the plasma is estimated to be 1×10^{13} eV/cm^3. The degree of plasma turbulence is found to be $\gtrsim 0.01$, which is in rough agreement with the result that Demidov et al. obtained by the combination scattering of the electromagnetic wave. (auth)

Kinetics (General)

Refer also to abstract 39914.

40054 INVESTIGATION OF HELIUM ARCS AT 10 atm PRESSURE. Hwang, C. C.; Emmons, Howard W. (Harvard Univ., Cambridge, Mass.). Phys. Fluids; 13: 2027-35(Aug 1970).

The measured "EI–ER" characteristics of wall-confined helium arcs at 10 atm pressure, when interpreted with the Elenbaas–Heller equation, show that the arcs are close to local thermodynamic equilibrium (LTE). A spectroscopic measurement is also made to investigate possible deviations from LTE. The results show that, despite overall indications of a closer approach to LTE at 10 atm than at 1 atm, the 10 atm arcs are still not in LTE in the region near the walls. Theoretical criteria of LTE tend to support the above results that is approached when the

arc pressure is raised, but the complete LTE is not attained at 10 atm. It is believed that the deduced transport properties from the arc measurement with the aid of the Elenbaas–Heller equation are the first approximations. The deduced electrical conductivity and thermal conductivity agree with the theoretical prediction of Lick and Emmons within a factor of 2. (auth)

40055 DETERMINATION OF DIFFUSION COEFFICIENTS BY CORRELATION OF MICROSCOPIC DENSITY FLUCTUATIONS. Mills, G. S.; McLane, C. K.; Tsukishima, T. (Environmental Science Services Administration, Boulder, Colo.). Phys. Fluids; 13: 2135-40(Aug 1970).

The cross spectrum of density fluctuations in an rf-heated abnormal glow discharge plasma is determined using Langmuir probes as sensors. The form of the cross spectrum and its dependence on probe separation, gas pressure, and electron temperature are in agreement with a theory given by Weinstock for a neutral collision dominated electron gas. If the diffusion coefficient obtained from fitting the theory to experiment is interpreted as an ambipolar diffusion coefficient, it is found to be in satisfactory agreement with that calculated from measured electron and gas temperatures and gas pressure, utilizing the known mobility of helium ions in helium. (auth)

40056 EXPERIMENTAL DETERMINATION OF THE THERMAL CONDUCTIVITY IN LOW-TEMPERATURE PLASMA. Asinovskii, E. I.; Kirillin, A. V.; Shabashov, V. I. (Inst. of High Temperatures, Moscow). pp 283-93 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

The measurements of the thermal conductivity of plasmas of argon, nitrogen, and air were carried out at atmospheric pressure and in the temperature range 6,500 to 16,500°K. The source of plasma was an electric arc stabilized by water-cooled copper walls. The dependence of the electric field intensity and of the radial distribution of temperature on the current of the arc for different diameters of the stabilizing channels (for argon plasma: d = 4, 6, and 8 mm; for nitrogen plasma: d = 3 and 5 mm; for air plasma: d = 5 mm) were studied. It is shown that in such arcs the mechanism of heat transfer is not exclusively thermal conduction. A method is proposed which enables one to determine both the thermal conductivity and the total emissivity of plasma. The experimental results are compared with theoretical calculations. (auth)

Kinetics (Experimental)

40057 (AD-703743) STUDIES OF CAVITY RESONATORS CONTAINING MAGNETOPLASMAS. Kent, Gordon; Thomas, Donald G. (Syracuse Univ., N. Y. Dept. of Electrical Engineering). Feb 1970. 44p. (TR-70-1; AFOSR-70-521-TR). CFSTI.

Cylindrical cavity resonators containing weakly ionized gases, principally argon, in the pressure range of 0.05 to 0.1 torr are studied. The plasma, produced either by microwave or dc power, is magnetized by a uniform axial field. Measurements of resonant frequency, made over a range of plasma densities and magnetic field are compared with the calculations of the theory given by Kent. The agreement is good providing the cylindrical degeneracy of the cavity is preserved and the plasma is reasonably uniform. Experimental and analytical results are used to evaluate perturbation theory, and some simple formulas, useful for diagnostic purposes, are given. A perturbation method for correcting the theory to account for symmetrical nonuniformities is proposed, and it is applied to the experimental data with apparent success. The method offers the possibility of determining both uniformity and density from measurements of frequency in one microwave band. (auth) (USGRDR)

40058 (AD-705200) ELECTRIC ARCS IN TURBULENT FLOWS. IV. Final Report, February 1967–December 1969. Frind, Gerhard; Damsky, Ben Lee (General Electric Co., Philadelphia, Pa. Power Transmission Div.). Jan 1970. Contract F33615-67-C-1374. 90p. (ARL-70-1). CFSTI.

Heat, mass, and momentum transfer were investigated experimentally in very long cylindrical axial flow arcs in laminar and turbulent flow conditions. Special attention was given to assure that the end of the arc tube had a section of fully developed flow. In this section the number of significant terms in the energy balance equation is reduced, and experimental results are interpreted. Strong evidence is presented for the existence of turbulence by the fact that all three transfer mechanisms are considerably accelerated in what is considered the 'turbulent mode' and also by direct optical study of the arc by a light probe. The onset of turbulence was found with all the methods to occur around 1.5 gram/sec gas flow rate. A considerable number of measurements of heat and momentum transfer are presented in the following operating ranges: Gases, argon and nitrogen; tube diameters, 0.5 and 0.7 cm; tube length, 50 cm; mass flow rates, 0.1 to 15 gram/sec; ambient pressure, 1 to 20 atmosphere; and currents, 25 to 200 amperes (some higher). (auth) (USGRDR)

40059 (ORNL-TM-3038) ANOMALOUS RESISTIVITY IN A STEADY-STATE, CURRENT CARRYING DISCHARGE TUBE PLASMA. Hirose, A.; Alexeff, I.; Jones, W. D.; Lonngren, K. E. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 15p. Dep. CFSTI.

The dc electrical conductivity in a turbulent cylindrical discharge-tube plasma was measured as a function of dc electric field over the range 0.06 to 300 V/cm. The observed conductivity is much lower than that due simply to collisions of electrons with ions and neutrals, and is explained in terms of current-driven electrostatic instabilities. Below approximately 60 V/cm the conductivity exhibits three distinct dependences upon the dc electric field, each of which can be interpreted quantitatively in terms of the ion–acoustic wave instability. Above 60 V/cm the conductivity is approximately constant and about an order of magnitude lower than that calculated by Buneman for the two-stream instability and observed experimentally by Hamberger and Friedman in a transiently turbulent plasma. In some cases, the relative electron density fluctuations $|\Delta n_e/n_e|$ were observed to approach unity. (auth)

40060 OBSERVATION OF PLASMA SATELLITES NEAR HeI FORBIDDEN LINES DURING TURBULENT HEATING OF A PLASMA. Zelenin, G. V.; Kutsyn, A. A.; Maznichenko, M. E.; Pavlichenko, O. S.; Suprunenko, V. A. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 58: 1879-83(Jun 1970). (In Russian).

Satellites in a turbulent plasma of a strong-current linear gas discharge (z-pinch) were detected and investigated near three forbidden lines of He I. The satellites have been predicted by Baranger and Moser. Time measurements of the position and intensity of the satellites yield the electron density and the time variation of the level of the plasma oscillations. Observation of satellites is a new contactless method for investigating a turbulent plasma. (auth)

40061 INFLUENCE OF METALLIC WALLS ON PLASMA DIAMAGNETIC MEASUREMENTS. Bottiglion, F. Plasma Phys.; 12: 131-5(Feb 1970).

The diamagnetic voltage is calculated for a coil surrounding a plasma in a metallic liner, and allowance is made for the eddy currents generated in the walls. (UK)

40062 PLASMA PROCESSES IN A LOW-PRESSURE SPARK DISCHARGE. Epstein, H. M.; Gallagher, W. J.; Mallozzi, P. J.; Stratton, T. F. (Battelle Memorial Inst., Columbus, Ohio). Phys. Rev., A; 2: 146-54(Jul 1970).

Measurements on a 60-kV 1-μF vacuum spark discharge indicate the following sequence of events. During the early stages of the discharge, the current is carried mostly by electrons which are accelerated to the full tube voltage, as seen from intense bremsstrahlung x-ray production at the anode. The fast electron current and accompanying x-ray emission then diminish, but the total current continues to increase. During the time of reduced x-ray emission, the plasma emits a strong microwave pulse which peaks near the frequencies of characterizing the electron drift instabilities. The dense beam of fast electrons then reappears for about 50 nsec and the whole cycle repeats, perhaps twice more. Although the fast electron stream repeatedly appears and disappears, the total current (fast stream plus drift current) usually rises monotonically. When a current of about 4×10^4 A is reached (in $\sim 5 \times 10^{-7}$ sec), dense material vaporized from the anode reaches the cathode and the tube impedance collapses. These events are explained in terms of a model which treats the discharge as alternating between two current modes, one dominated by a fast electron beam, the other by electron drift instabilities. (auth)

40063 INSTABILITY NEAR THE ION PLASMA FREQUENCY IN A BEAM–PLASMA SYSTEM. Vermeer, A.; Kistemaker, J. (FOM-Inst. for Atomic and Molecular Physics, Amsterdam). Plasma Phys.; 12: 95-103(Feb 1970).

In a beam–plasma experiment the instability near the ion plasma frequency is studied. In a helium plasma under the experimental conditions this instability has a frequency below 10 MHz. Wavelength measurements at this instability were made by a double probe. Excitation of the ion waves is brought about by the slow cyclotron harmonic waves on the electron beam. Multiple modes of the interaction peak are observed and are caused by interactions, which are determined by different-order Bessel functions. (auth) (UK)

40064 STATIONARY CONVECTIVE CELLS IN A STREAMING PLASMA COLUMN. Cataldo, Joseph C. (City Coll., New York). Phys. Fluids; 13: 2195-8(Aug 1970).

Observations of a low-β plasma indicate that, at low magnetic fields, a distinct stationary cellular pattern sets in, resulting in a density one order of magnitude higher than that at higher magnetic fields. (auth)

40065 MEASUREMENT OF THE TEMPERATURE AT THE FRONT OF STRONG SHOCK WAVES IN ELECTRIC DISCHARGE SHOCK TUBES. Gorelov, V. A.; Frolov, Yu. K. Zh. Tekh. Fiz.; 40: 825-32(Apr 1970). (In Russian).

The results of the measurement of the temperature at the front of the strong shock waves in electric discharge shock tubes of the diaphragmless type are reported. The initial air pressure is p_0 = 0.3 to 1.0 mm Hg and the velocity of the shock wave is V_s = 4 to 9 km/sec. In this operating regime the front of the shock wave was separated from the pushing gas-discharge plasma and is, essentially, the gage of the shock of the heated gas. The temperature was measured by the method of spectral line inversion, the range of the measurement was extended laterally to a gas density $\rho \approx 10^{-5}$ g/cm^3. Time resolution was attained in $\tau \approx 1.5$ to 2×10^{-6} sec. At p_0 = 0.5 and 1.0 mm Hg and V_s = 6 to 7 and 5 to 5.5 km/sec, a chart was obtained of the distribution of temperature from the shock wave. It was found that in all regions of V_s and p_0 investigated the temperature, measured in the gas region adjoining the wave front, agrees well with the corresponding calculated values. (tr-auth)

40066 INVESTIGATION OF COLLISIONLESS SHOCK WAVES IN MAGNETIZED PLASMA. Zagorodnikov, S. P.; Smolkin, G. E.; Striganova, E. A.; Sholin, G. V. Zh. Tekh. Fiz.; 40: 717-27(Apr 1970). (In Russian).

The structure of the front and the character of the propagation of the linear collisionless shock waves in plasma were investigated as a function of the Alfven-Mach number M_A. The jump of the electron temperature at the wave front was measured spectroscopically. The results obtained were interpreted on the basis of a turbulent mechanism of dissipation. During increase of the number M_A, specific irreversible processes were observed, related probably, to the increase of the efficiency of the collisionless dissipation process and with change of the character of the interaction of the variable magnetic field with increase of its amplitude. (tr-auth)

40067 DISTRIBUTION OF TOTAL PRESSURE IN THE PLASMA FLOW EMERGING FROM A QUASI-STATIONARY INJECTOR. Kislov, A. Ya.; Morozov, A. I. Zh. Tekh. Fiz.; 40: 768-71(Apr 1970). (In Russian).

The distribution of the total pressure in the flow of plasma emitted from quasi-stationary plasma injectors with intrinisic magnetic fields was investigated. The complete pressure was measured by pressure transducers, the sensitive elements of which were barium titanate piezocrystals. The method of calibration of the pressure transducers by means of "magnetic" shocks is described. The method permits not only the determination of the sensitivity of the transducer but also its inherent frequency. It is shown that the character of the distribution of the total pressure of the yield from the injector directly depends on the polarity of the central electrode, which depends on the formation of Hall currents in the volume of the injector. (tr-auth)

40068 MAGNETIC FIELDS AND DENSITY OF PLASMA IN THE GAP OF PULSED PLASMA INJECTOR. Val'kov, Yu. A.; Zbrailova, N. L.; Skvortsov, Yu. V. Zh. Tekh. Fiz.; 40: 772-80(Apr 1970). (In Russian).

The coaxial plasma injector with pulsed admission of hydrogen was examined. The outer electrode of the injector was composed of 12 copper rods with a diameter of 14 mm, arranged in a circle with a radius of 5.5 cm. The length of the rods was 40 cm. The central electrode was a copper rod with a diameter of 32 mm with an opening for admission of hydrogen into the gap. The openings were arranged at 37 cm from the section of the accelerator and admitted into the gap 0.4 cm^3 of hydrogen at pressures of 5 to 6 atm. Condenser batteries with 5.4 μF capacity charged to 25 kV were connected to the accelerator electrodes. The discharge current was 100 kA and its period was 6μsec. The spatial distribution of the magnetic fields and the concentration of the charged particles in the injector gap were found. It was found that three stages of the process exist: ionization of the gaseous cloud, movement of the current layer along the ionized gaseous cloud, and acceleration of the clusters. The parameters of the plasma in all stages were evaluated. It was established that the admission of impurities broke the acceleration of the clusters to 8 to 10 cm at the aperture for admission of the gas to the gap. (tr-auth)

40069 MEASUREMENT OF THE DISTRIBUTION OF ATOMS AND ELECTRONS ACROSS THE CAPILLARY CROSS SECTION IN HIGH-CURRENT DISCHARGES. Gur'ev, T. T.; Kyun, V. V.; Ostapchenko, E. P.; Stepanov, V. A. Zh. Tekh. Fiz.; 40: 781-4(Apr 1970). (In Russian).

The radial distribution of the concentration of electrons and neutral atoms of argon in high-current dc discharges in capillaries with diameter of 2.4 mm was measured by means of the Rozhdestvenskii interferometer and helium–neon laser with emission of two long waves (0.63 and 3.39 μ). The gas pressure was varied from 0.5 to 2 mm Hg and the current from 6 to 12 A. (tr-auth)

40070 INVESTIGATION OF THE SUPERHIGH-FREQUENCY RADIATION FROM PLASMAS DURING INTERACTION OF ELECTRON BEAMS WITH FAST MAGNETO-ACOUSTIC WAVES. Ermakov, A. I.; Nazarov, N. I. Zh. Tekh. Fiz.; 40: 785-9 (Apr 1970). (In Russian).

The super-high frequency radiation from plasma was studied during interaction of an electron beam with fast magneto-acoustic waves, excited by external high-frequency spatial–periodic currents (f = 10 MHz). It was found that the passage of the electron beam across the plasma, in which fast magneto-acoustic waves were excited, was accompanied by energetic shf radiation. The frequency of this shf radiation coincides with the plasma frequency of the electrons. The presence of this strong radiation was probably caused by the effective transformation of longitudinal plasma oscillations, excited by the electron beam in inhomogeneous dense plasma or created by the fast magneto-acoustic waves. The relation of the shf radiation at 37 GHz to different parameters of the plasma and electron beam was deduced. (tr-auth)

40071 EXPERIMENTAL DETERMINATION OF PLASMA TRANSPORT PROPERTIES. Schreiber, P. W.; Schumaker, K. H.; Benedetto, K. R. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). pp 249-63 of Thermal Conductivity. /Ho, C. Y. (ed.). New York; Plenum Press (1969).

From 8th Annual Conference on Thermal Conductivity, Lafayette, Ind. See CONF-681009.

An approach is outlined for the experimental determination of plasma transport properties at temperatures up to 15,000°K. Properties included in the study are electric conductivity, thermal conductivity, radiation source strength, and viscosity. A plasma source was designed and constructed to provide the required stable conditions for the investigation. The required diagnostic techniques are developed and preliminary measurements are presented. Advantages include the determination of electrical conductivity without making assumptions about the analytical form of the transport properties or the validity of the nonabsorbing energy equation. In addition, radiation source strength is measured over the entire wavelength range of importance. (auth)

40072 OPTICAL STUDIES OF PLASMA-FLOW INTERACTIONS WITH LARGE MAGNETIC FIELDS. Willeke, K.; Zimmermann, W.; Muntenbruch, H.; Sardei, F. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch.; 25a: 786-7(May 1970).

Experiments were performed with a plasma flowing into a strong magnetic field B, applied perpendicularly to the flow (of velocity v) in a Faraday-generator-type test chamber. An induced $v \times B$ emf causes an electric current j to flow in the plasma. The current paths are closed through electrodes that are externally short-circuited. A retarding force $j \times B$ acts in opposition to the plasma flow direction, and Joule heating converts kinetic to thermal energy. These two phenomena may choke the gas so strongly that a shock is generated which then propagates upstream out of the interaction zone. The existence and the path of such a shock wave has been predicted theoretically, but no conclusive evidence of such a shock had been given experimentally. The present study confirms the theoretical predictions. (M.O.W.)

40073 ANALYSIS OF IONS EXTRACTED FROM A PLASMA PUFF IN MAGNETIC GUIDE FIELDS. Leffel, Claude S. Jr. (Johns Hopkins Univ., Silver Spring, Md.). J. Appl. Phys.; 41: 3759-67(Aug 1970).

An iron skimmer and extractor tube were used to extract ions from a high-β plasma puff as it traveled down B_z and octopole magnetic guide fields. The plasma puff was generated by a theta-pinch plasma gun operating with H_2. The extracted ions were analyzed by a cross-field velocity analyzer in series with an electrostatic energy analyzer. For the case of the octopole guide field, analysis of the energy spectrum yielded values for the plasma parameters in good agreement with other determinations. For the B_z guide field, the magnetic field trapped in the extractor apparatus produced a magnetic barrier that reflected the plasma so as to distort the energy spectrum and produced temperature

estimates that were too high and density estimates that were too low. However, for the B_z guide field, an upper limit could be placed on the concentration of impurity ions. (auth)

40074 TRANSITION FROM THE THREE-BODY TO THE DISSOCIATIVE ELECTRON–ION RECOMBINATION IN AN ARGON PLASMA. Funahashi, Akimasa; Makihira, Tsuneichi; Takeda, Susumu (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 29: 441-6 (Aug 1970).

Results of a study concerned with transition from the three-body to the dissociative electron–ion recombination in an argon plasma are presented. Measurements were performed using the propagation technique of the 8-mm wave in decaying plasmas produced behind reflected shock waves in a T-type tube filled with argon at initial pressures from 5 to 18 torr. The electron densities and temperatures were in the ranges from 10^{13} to 10^{19} cm^{-3} and 10^3 to 3×10^3°K, respectively. The recombination coefficients determined from the measured density decays are explained by the three-body recombination process for the electron densities above 10^{12} cm^{-3}. The coefficients, on the other hand, are interpreted by the dissociative process for the electron densities below 10^{11} cm^{-3} with the electron temperatures close to 3×10^3°K. The transition between these two processes is discussed. (auth)

40075 DIRECT MEASUREMENT OF THE MAINTENANCE VOLTAGE OF A THERMAL INDUCTION PLASMA. Eckert, Hans U. (Aerospace Corp., El Segundo, Calif.). J. Appl. Phys.; 41: 3633-7(Aug 1970).

The axial distribution of voltage induced near the inner wall of a 3.8-cm-diam tube confining an rf argon induction plasma at atmospheric pressure was measured at a flow rate of 115 cm^3/sec with a water-cooled ring probe. Also measured as functions of probe position were the excitation frequency, voltage, and current on the inductor coil. The plasma reduced the probe voltage to about 60% of its value in the absence of the plasma. After correction for the effects of cooling and displacement of the plasma by the probe, the total induced voltage around the circumference of the plasma at the midsection was found to be 64 V. The corresponding value for electric-field intensity was 6 V/cm. This value falls between published values obtained by indirect methods and is in fair agreement with prediction on the basis of a one-dimensional theory. (auth)

40076 INTERPRETATION OF EXPERIMENTAL SPECTRA OF COOPERATIVELY SCATTERED LASER LIGHT. Niland, R. A. (Univ. of Sydney). Phys. Lett.; 32A: 280-1(27 Jul 1970).

Profiles of light scattered from a H_2 plasma are analyzed using the distribution of power between the ion and electron features to determine the cooperative parameter α. The results agree with the usual methods of analyzing scattering spectra and with spectroscopic measurements. (auth)

Kinetics (Theoretical)

40077 (AD-705162) THE INTERACTION BETWEEN LOCAL CURRENTS, INDUCED IN A PARTIALLY IONIZED GAS FLOW, AND A MAGNETIC FIELD. Petrova, G. P. Translated by M. Olaechea from pp 48-51 of Fizicheskaya Gazodinamika Ionizirovannykh i Khimicheski Reagiruyushchikh Gazov, Moscow, 1968. 10p. (FTD-HT-23-148-70). CFSTI.

An expression for the magnitude of the induced voltage generated during the flow of an ionized, conducting gas in a transverse magnetic field is derived. This derivation is based on the solution of a differential equation. The flow velocity vector, time, flow density, pressure, coefficient of viscosity, conductivity coefficient, magnetic vector, and induced current density are found where the electric conductivity, electric field vector, and the velocity of an infinitesimal mass of gas are known. The final expression for the induced voltage is given. (auth) (USGRDR)

40078 (IFA-FT-82) ELECTRONIC STRUCTURE OF Ar_{13}^+ ION CLUSTER. Mizushima, Masataka (Institutul de Fizica Atomica, Bucharest (Romania)). Apr 1970. 29p. Dep. CFSTI (U. S. Sales Only).

Theoretical calculations are presented of the electronic structure of a cluster ion with the icosahedral symmetry, such as Ar_{13}^+. The proposed structure is obtained by placing one each argon atom at the center, at each of twelve vertices, and at outside of each center of twenty triangular faces, of an icosahedron. (M.O.W.)

40079 NOTE ON THE MOTION OF CHARGED PARTICLES IN SUPERIMPOSED HOMOGENEOUS MAGNETIC AND COULOMB-TYPE ELECTRIC FIELDS. Infeld, E.; Kulinski, S. (Inst. of Nuclear Research, Warsaw). Plasma Phys.; 12: 136-40(Feb 1970).

The motion of charged particles in a Coulomb-type field plus a homogeneous field is discussed, and the position of the guiding center of a charged particle for various conditions is given. A calculation on the drift approximation is given. (UK)

40080 RADIATION CONDITION FOR A MAGNETOPLASMA MEDIUM. Seshadri, S. R. (Univ. of Wisconsin, Madison); Wu, T. T. Quart. J. Mech. Appl. Math.; 23: 285-313(May 1970).

The radiation condition for an unbounded magnetoplasma that is both anisotropic and dispersive is considered. The usual form of the celebrated Sommerfeld radiation condition pertains to an isotropic and nondispersive medium and is not applicable to a magnetoplasma. A technique based on the principle of causality for the resolution of the consequent ambiguity is discussed. The branch points and the associated branch cuts of the integrands in the Fourier integral representations of the two modes that compose the actual field component in a steady-state problem are examined, with particular emphasis on certain of the branch points that have been overlooked in the existing literature. (auth) (UK)

40081 RESPONSE OF A LORENTZIAN GAS TO AN ac PULSE. II. Kamal, Jyoti; Ghatak, Ajoy K. (Indian Inst. of Tech., New Delhi). Z. Phys.; 236: 245-9(1970).

An expression for the effective electron temperature was derived without neglecting the variation in time of the isotropic part of the distribution function. This expression differs from the one derived by Ghatak [Z. Physik, 226: 454(1969)]. (M.O.W.)

40082 THEORY OF A WEAKLY IONIZED PLASMA WITH STRONG INTERACTION. Yakubov, I. T. (Inst. of High Temperature, Moscow). Zh. Eksp. Teor. Fiz.; 58: 2075-8(Jun 1970). (In Russian).

A degenerate plasma whose nonideality is due to charged–neutral particle interactions is considered. The electron state density and equation for ionization equilibrium are obtained in the case of strong nonideality. The nonideal plasma is found to acquire semiconductor properties. A large number of localized electrons appear and the electric conductivity sharply rises. Concrete estimates are made for lithium and mercury plasmas. (auth)

40083 CORRELATION EFFECTS IN SEMI-INFINITE PLASMAS. Guernsey, Ralph L. (Univ. of Maryland, College Park). Phys. Fluids; 13: 2089-2102(Aug 1970).

The system of a fully ionized gas combined to a half-space by a perfectly reflecting boundary is discussed. It is shown how the effect of pair correlations can rigorously be taken into account in both the equilibrium and nonequilibrium theory. (auth)

40084 SIMULATION OF BINARY COLLISION PROCESSES IN PLASMAS. Oliphant, T. A.; Nielson, C. W. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids; 13: 2103-7(Aug 1970).

A numerical procedure for adding the effects of binary collisions to previously collisionless plasma simulation programs was developed. It is shown that the model faithfully reproduces a numerical solution to the Fokker–Planck equation. As an illustration of the effect of collisions, a mirror mode problem is solved in θ-pinch geometry. Solutions are displayed for varying collision frequencies and qualitative as well as quantitative differences are readily apparent. (auth)

40085 THEORY OF PLASMA SIMULATION USING FINITE-SIZE PARTICLES. Langdon, A. Bruce; Birdsall, Charles K. (Univ. of California, Berkeley). Phys. Fluids; 13: 2115-22 (Aug 1970).

The elementary properties of a plasma, in which the small-separation force is smoothed from the Coulomb force, are developed. The modification is considered as being produced by spreading out the charge distribution of a particle to make a particle of finite size R (cloud). These clouds move freely through one another and interact through normal electromagnetic fields. A method to adapt point-particle results for plasma oscillations, shielding, fluctuations, and collisions, is shown, and the modifications to these plasma properties discussed in detail. The relevance of these considerations to computer simulation of plasmas (in which some smoothing is a consequence of the numerical methods used and additional smoothing is sometimes added) is discussed. It is found that smoothing the short-wavelength interaction can be used without destroying the desired physics, while suppressing collisional effects and noise at wavelengths < R which are exaggerated in simulation due to the use of far fewer particles than in a real plasma. (auth)

40086 COLLISIONS IN A PLASMA OF FINITE-SIZE PARTICLES. Okuda, Hideo; Birdsall, Charles K. (Univ. of California, Berkeley). Phys. Fluids; 13: 2123-34(Aug 1970).

Collisions in one-, two-, and three-dimensional plasmas of finite-size particles, clouds, are studied from two different

points of view. The first approach starts from the dynamics of binary collisions and proceeds to obtain the interaction force between two clouds including the effect of static shielding which is then used to obtain the scattering cross section. The calculation shows that cloud cross sections are reduced by orders of magnitude compared with those of point particles as the cloud radius is made comparable to the Debye length. The second approach makes use of the kinetic equations of Balescu–Lenard and Landau from which the Fokker–Planck coefficients for a test cloud in an equilibrium plasma are calculated. It is shown that the Fokker–Planck coefficients for clouds also become considerably smaller than those for point particles when the cloud radius becomes comparable to the Debye length; in addition, the velocity dependence of the coefficients for thick clouds are different from those for point particles. As an application, it is shown that the high collision frequencies encountered in computer plasma simulation (N_D too small by normal plasma criteria) can be greatly reduced by use of clouds of radius comparable to the Debye length. (auth)

40087 IONIZATION AND RECOMBINATION PROCESSES IN A HOLLOW CATHODE DISCHARGE. Bueger, P. A.; Fink, W. (National Physical Research Lab., Pretoria). Z. Phys.; 236: 314–20(1970). (In German).

If a plasma is not in local thermal equilibrium it is necessary for the calculation of the ionization rate to know the elementary processes of ionization and recombination. Some calculations concerning these processes and the relevant probability coefficients under hollow-cathode-discharge conditions are given and an approximated equation for the ionization rate is developed and discussed. The possibility for the appearance of two distinct groups of electrons in a hollow-cathode discharge and their influence on the developed equation is also discussed. (auth)

40088 RESOLUTION OF THE DISPERSION EQUATION FOR PLASMA–BEAM SYSTEMS WITH CONSIDERATION OF COLLIDING ELECTRONS. Baranchuk, N. S.; Kotsarenko, N. Ya.; Levitskii, S. M. Zh. Tekh. Fiz.; 40: 733-9(Apr 1970). (In Russian).

An analytical solution of the dispersion equation for plasma–beam systems is made in the weak beam approximation, with consideration of the collision of the plasma electrons with heavy particles (neutral atoms or ions). Expressions are found for the complex coefficients of propagation in the vicinity of the synchronism of the plasma waveguide and beam waves. In the regime far from synchronism the possibility of resistance increase is shown. For regimes where the weak-wave approximation does not operate, the dispersion equation was solved by computer. (tr-auth)

40089 INVESTIGATION OF THE DYNAMICS OF PLASMA CURRENTS IN CORRUGATED MAGNETIC FIELDS IN THE PRESENCE OF THE HALL EFFECT. Kalmykov, A. A.; Tereshin, V. I.; Chebotarev, V. V. Zh. Tekh. Fiz.; 40: 754-63 (Apr 1970). (In Russian).

The dynamics of plasma currents in corrugated axisymmetric magnetic fields were studied under the conditions where multicomponent currents are induced by the presence of the Hall effect. The structure of the current was investigated, and the conditions of its formation were analyzed. On the basis of the current distribution found in the plasma, it was shown that the closing of the Hall current occurs at the boundary of the plasma formation. Account of the Hall effect during analysis of the interaction of moving plasma with magnetic fields made it possible to explain some characteristics of the interaction, in particular, the reason for the fast attenuation of the induced current in the plasma. (tr-auth)

40090 NUMERICAL STUDY OF THE INDUCTIVE ELECTRODELESS DISCHARGE. Pridmore-Brown, D. C. (Aerospace Corp., El Segundo, Calif.). J. Appl. Phys.; 41: 3621-5 (Aug 1970).

A numerical study is reported of the equations describing the steady state of a column of thermal plasma that is heated inductively by a radio-frequency axial magnetic field. The electric and thermal conductivities and the specific radiation of the plasma are taken to be given functions of the temperature. A numerical technique is described which yields self-consistent solutions for given values of the input parameters, these being the frequency and the number of ampere turns per unit length of the driving solenoid, and the radius of the tube. Typical results are shown for an argon plasma at atmospheric pressure. (auth)

40091 NUMERICAL SIMULATION OF ELECTROSTATIC COUNTERSTREAMING INSTABILITIES IN ION BEAMS. Forslund, D. W.; Shonk, C. R. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 25: 281–4(3 Aug 1970).

Two-dimensional numerical studies are reported of the nonlinear evolution of the electrostatic instabilities of two interpenetrating ion beams in an electron background, and comparison with the predictions of linear and quasilinear theory. (auth)

40092 EXCITATION OF WAVES IN MAGNETOACTIVE PLASMA BY A STRONGLY "SPREAD" INHOMOGENEOUS ELECTRON BEAM. Jungwirth, K. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 20: 763-9(1970).

The stability of beam–plasma systems is studied assuming that the distribution of beam electrons in the velocity space corresponds to the first period of the quasi-linear equations to be applicable within the whole period of quasi-linear relaxation. (auth)

Production

40093 (AD–704586) LOW-FREQUENCY INDUCTION PLASMAS. Report for June 1968–December 1969. Eckert, Hans U. (Aerospace Corp., El Segundo, Calif.). 27 Feb 1970. Contract F04701-69-C-0066. 17p. (TR–66(9220-2)-7; SAMSO-TR–70-151). CFSTI.

The possibility of generating thermal electrodeless plasmas at frequencies below the rf range through the use of magnetic materials is investigated analytically and experimentally. Existing minimum frequency and voltage criteria for the maintenance of quasi-steady, tube-filling ac arcs are combined with the induction law to yield design criteria for a plasma transformer that has a conventional iron core and primary, but has the secondary replaced by a torus-shaped vessel that contains a single plasma turn. The feasibility of the idea is demonstrated on a small model with an iron core of 100 cm^2 cross section at a frequency of 9600 Hz, generating 220 V per turn in the unloaded state. Steady discharges were obtained in argon at pressures up to 500 torr, in which case the plasma current at this pressure was 100 A and the maintenance voltage was 120 V. The estimated minimum dimensions for maintaining an atmospheric-pressure argon plasma at 60 Hz are 30 cm for the core radius and 4 cm for the small radius of the torus. (auth) (USGRDR)

40094 SUBSONIC PROPAGATION OF A LIGHT SPARK AND THRESHOLD CONDITIONS FOR MAINTENANCE OF A PLASMA BY RADIATION. Raizer, Yu. P. (Inst. of Mechanics Problems, Moscow). Zh. Eksp. Teor. Fiz.; 58: 2127-38(Jun 1970). (In Russian).

Subsonic conditions for propagation of a laser spark similar to those of slow combustion are considered. The steady-state problem is formulated and solved approximately. The plasma temperature wave velocity and threshold power required for existence of a nondecaying wave are found. Good agreement with available experimental data obtained by aid of a neodymium laser is obtained. The possibility of designing a light plasmatron based on a continuous-operation CO_2 laser is discussed. For maintenance of a plasma in air, a light power of about 2 kW is required. The temperature of such a plasma is 18,000°K. (auth)

40095 NATURE OF IONIZATION IN A PHOTORESONANT CESIUM PLASMA. Morgulis, N. D.; Przhonskii, A. M. (Kiev State Univ.). Zh. Eksp. Teor. Fiz.; 58: 1873-8(Jun 1970). (In Russian).

In continuation of previous work the nature of ionization in a photoresonant cesium plasma is further studied: (1) the optical-pumping spectral region active for ionization is elucidated; (2) the properties of the plasma electron gas are determined; (3) molecular as well as atomic cesium ions are detected in the plasma by the mass-spectrometer technique and the ratio of the ions under various experimental conditions are measured; and (4) dynamics of the development and decay of plasma is measured separately for molecular and atomic ions. Some conclusions are made concerning the nature of processes in such a plasma. (auth)

40096 MODEL OF AN IONIZING CURRENT SHEET. Pert, G. J. (Univ. of Alberta, Edmonton). J. Phys., A (London); 3: 421-6(Jul 1970).

The steady-state structure of an ionizing current layer (sheet) propagating into a cold un-ionized gas was examined using a collision-free self-consistent-field approach. The results parallel those for a collision-dominated plasma; in particular, it was found that the magnetic field may not reverse through the layer. The structure of the sheet is not steady-state unless there is a large ambient magnetic field, or collisions destroy the coherence of the particles' motion after they leave the "sheet." A sheet propagating into a strong magnetic field with long ion mean free path is shown to behave like a snowplough. (auth) (UK)

40097 A SPECTROSCOPIC INVESTIGATION OF PLASMA PARAMETERS AT THE OUTLET OF A PLASMATRON. I. AN

INVESTIGATION OF THE RADIAL DISTRIBUTION OF ELECTRON DENSITY IN ARGON. Golubovskaya, S. M.; Golubovskii, Yu. B.; Kagan, Yu. M. Opt. Spectrosc. (USSR) (Engl. Transl.); 28: 122-4(Feb 1970).

Translated from Opt. Spektrosk.; 28: 223-7(Feb 1970).

The radial distribution of the electron concentration in argon was studied by means of the spectral line shift. (auth)

40098 NEW TYPE OF PLASMA SOURCE. Horikoshi, Gen'ichi; Kuroda, Tsutomu; Nagao, Shigeo (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 29: 459-63(Aug 1970).

The construction and the performance of a new type of plasma source, designed by applying a magnetic field similar to that in the divertor of the stellarator, are described. The plasma parameters are measured by Langmuir probes. A hollow plasma of He with a density of the order of 10^{10} particles/cm^3 is produced along the separatrix line of force in this apparatus. The fluctuation of the plasma density is rather small. Since this new type of plasma source has no electrode on the axis, it is possible to use it for a stationary torus machine. (auth)

40099 ANALYSIS OF A RADIO-FREQUENCY STRUCTURE USED FOR PLASMA PRODUCTION AND HEATING. Orefice, A.; Pozzoli, R. (Univ., Milan). J. Appl. Phys.; 41: 3739-44(Aug 1970).

Characteristics and electromagnetic fields, in vacuum, of a widely used slow-wave line are studied theoretically. The main interest of such a structure is connected with its performances as a plasma-producing, -heating, and -ejecting device. (auth)

Stability

Refer also to abstracts 40063, 40091, and 40145.

40100 (AD-704621) DYNAMIC STABILITY OF CLOSED PLASMA CONFIGURATIONS. Wells, Daniel R. (Miami Univ., Coral Gables, Fla. Dept. of Physics). 1 Feb 1970. Contract AF-AFOSR-844-67. 48p. (MIAPH-PP-70-2; AFOSR-70-1017-TR). CFSTI.

Supersedes AD-700106.

The global stability of closed plasma configurations is related to the dynamical principle of least constraint and the space-time and gauge symmetries of the flow fields. This leads to an entirely new concept of MHD stability, which is more basic than stability predictions that rely on a linearized perturbation analysis. The predictions of the theory are compared to recent experimental results obtained in studies of the stability of plasma-confinement geometries. The theory predicts the violent instabilities of these systems that are currently attributed to other mechanisms. Several pertinent details of the theory that are widely misinterpreted are discussed and clarified. (auth) (USGRDR)

40101 (UCRL-72473) FEEDBACK CONTROL OF FLUCTATIONS IN A TOROIDAL STELLARATOR. Hartman, C. W.; Hendel, H. W.; Munger, R. H. (California Univ., Livermore. Lawrence Radiation Lab.). 4 Jun 1970. 15p. (CONF-700616-1). Dep. CFSTI.

From Symposium on Feedback and Dynamic Control of Plasmas, Princeton, N. J.

Identification of fluctuations and their suppression or enhancement by feedback is discussed for plasma confined in a toroidal stellarator. Microwave-produced Xe plasma having parameters $n \simeq 10^{11}$ cm^{-3}, $T_e \simeq 1$ eV is studied in confining fields $B \simeq 1$ kG. A critical threshold in helical winding current is observed above which the fluctuation level $\tilde{n}/n \gtrsim 1\%$ and below which low-order coherent fluctuations having $\tilde{n}/n \simeq 10\%$ are observed. The fluctuations are identified as ballooning-type drift waves. Below the threshold helical winding current, unfiltered feedback of appropriate phase is observed to suppress the dominant lowest-order mode while a higher-order mode appears. Above the threshold current excitation of oscillations by regenerative feedback to a level $\tilde{n}/n \simeq 10$ to 20% does not appreciably increase the rate of plasma loss under conditions $\tau_{confinement} \simeq 10\ \tau_{Bohm}$. (auth)

40102 DIAMAGNETISM CAUSED BY WAVES IN A PLASMA. Klima, R. (Inst. of Plasma Physics, Prague). Plasma Phys.; 12: 123-9(Feb 1970).

Electromagnetic waves give rise to nonlinear time-averaged forces that affect the equilibrium of plasma in a magnetic field. Conditions for the equilibrium in the direction perpendicular to a stationary magnetic field are derived from a simple theoretical model. The dependence of wave pressure on the local wave energy density is found for several types of waves. If the energy of the waves is comparable to or higher than the plasma thermal energy, then the wave can distort a diamagnetic signal used for measurement of plasma temperature. (auth) (UK)

40103 STABILIZATION OF THE ANTISYMMETRICAL MODE OF CYCLOTRON INSTABILITY OF A LOW-DENSITY PLASMA IN OGRA-2 WITH THE AID OF A FEEDBACK SYSTEM. Zhil'tsov, V. A.; Likhtenshtein, V. Kh.; Panov, D. A. JETP Lett. (USSR) (Engl. Transl.); 11: 131-2(20 Feb 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 213-15(20 Feb 1970).

The possibility of suppressing the antisymmetrical mode in Ogra-2 with a complicated wave structure is discussed. The feedback system included an electrostatic antenna offset from the central plane of the trap by a distance equal to half the plasma radius, and located on the surface of the vacuum chamber. Stabilization of the instability was observed in a relatively narrow phase interval spanning about 60°. (M.O.W.)

40104 ENERGY CRITERION FOR STABILITY OF EQUILIBRIUM PLASMA GIVEN BY STATIONARY DISTRIBUTION FUNCTION. Lacina, J. (Inst. of Plasma Physics, Prague). Plasma Phys.; 12: 83-8(Feb 1970).

Exact conditions for stability of an equilibrium collisionless plasma (given by a stationary distribution function) in a given nonuniform magnetic field are derived by the use of a variational method. The discussion concerns examination of the stability of low-β plasma against perturbations, preserving two constants of motion. The formulation is quite general in that it is not restricted to guiding-center or homogeneous plasmas. (auth) (UK)

40105 INSTABILITY OF PLASMA. Pellat, R.; Laval, G. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Riv. Nuovo Cim.; 1: Special No., 214-51(1969). (In French).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

A review is given of various microinstabilities and macroinstabilities in plasma research. Magnetohydrodynamic instabilities, Langmuir wave instabilites, and instabilities from uniform and nonuniform magnetic fields are described. (M.O.W.)

40106 INTERACTION OF NEGATIVE MASS AND LOSS CONE MODES. Berk, H. L.; Pearlstein, L. D.; Walters, G. M. (Univ. of California, Livermore). Phys. Fluids; 13: 2141-6 (Aug 1970).

The standard negative mass instability is investigated for a thin layer of charge, oriented concentrically about the axis of symmetry of the magnetic field and immersed in a plasma background. The radius of the charge layer is taken to be equal to the gyroradius of the particles forming the layer. The dispersion relation that describes the interaction of the perturbed layer charge with the plasma background is obtained. Substantial modification to the dispersion relation arises at the first cyclotron harmonic due to beam-plasma interaction. Furthermore, a stable beam mode, predicted at the hybrid frequency in the low-temperature plasma theory, does not occur in this system. (auth)

40107 NONLINEAR EVOLUTION OF MULTIPLE-FINITE AMPLITUDE RESONANT LOSS-CONE MODES. Aamodt, R. E. (Univ. of Texas, Austin). Phys. Fluids; 13: 2147-61(Aug 1970).

The dynamics of hot particles moving in the presence of several finite amplitude longitudinal flute modes with frequencies near a harmonic of the cyclotron frequency are derived. It is found that, in general, such electric fields cause sizable groups of particles to lose or gain a substantial fraction of their kinetic energy. The dynamics are then self-consistently applied to the problem of determining the nonlinear evolution of the resonant hot-cold species loss-cone instabilities. For this model it is shown that nonlinear stabilization takes place through large particle excursions in velocity space and by the nonlinear detuning of the system out of resonance. An estimate of the energy exchange process shows that, at any time, only a small fraction of the initial hot-particle free energy is in the form of electric field fluctuations; most of the available energy is transformed into heating of the high-energy tail of the ions. The final state of this system is shown to be a stable, completely quiescent extremely hot plasma. (auth)

40108 MEANS OF CLASSIFYING CONVECTIVE AND ABSOLUTE INSTABILITIES. Baldwin, D. E. (Yale Univ., New Haven); Rowlands, G. Phys. Fluids; 13: 2036-8(Aug 1970).

A simple numerical procedure for distinguishing convective and absolute instabilities is described. (auth)

40109 HARRIS INSTABILITIES IN A PLASMA OF FINITE LENGTH. Colchin, R. J.; Dunlap, J. L. (Oak Ridge National Lab., Tenn.). Phys. Fluids; 13: 2045-54(Aug 1970).

The experimental observations concern particular microinstability modes found in a short, highly anisotropic ($T_{\parallel}/T_{\perp} \approx 0.005$), hot ion plasma ($\omega_{pe} \gtrsim \omega_{ci} > \omega_{pi}$) formed by fast H^0 injection into a

simple magnetic mirror field. These modes were characterized by B_θ probe signals at ion gyrofrequencies and also at discrete sidebands of comparable amplitude about the gyrofrequencies. Sidebands were related to mirror bounce motions of the ions by experiments using different magnetic field gradients. The presence of high-amplitude sidebands and observations of an antisymmetric axial potential distribution associated with one of the oscillations indicated that the modes were those of Harris instability rather than of negative mass. Comparisons of observations with results of numerical studies of Harris instability in infinite media and with finite length effects confirmed the assignment. (auth)

40110 NONLINEAR STABILIZATION OF HIGH-FREQUENCY INSTABILITIES IN A MAGNETIC FIELD. Dum, Christian T. (Cornell Univ., Ithaca, N. Y.); Dupree, Thomas H. Phys. Fluids; 13: 2064-81(Aug 1970).

It is shown that the broadening of wave–particle resonances by the random motion of particles in a turbulent electric field may determine the saturation level of a variety of high-frequency instabilities. Secular changes of the guiding center positions, cyclotron radii, and phase angles give rise to resonance broadening and diffusion, similar to that produced by collisional scattering. The field dependent broadening is expressed in terms of resonance functions which replace the familiar resonant denominators of the linear theory. Resonance functions are derived in a simple manner from the solution of a Brownian motion problem, leading to an expression in terms of diffusion coefficients. The close resemblance of the theory to quasilinear theory and the linear theory including collisions allows one to start from a linear stability analysis and then assess the importance of nonlinear effects. This method is illustrated by the determination of the saturation level of cyclotron instabilities from the condition of vanishing nonlinear growth rate. (auth)

40111 USE OF THE VARIATIONAL METHOD DURING INVESTIGATION OF DISSIPATIVE INSTABILITIES IN PLASMA. Kogan, E. Ya.; Moiseev, S. S.; Oraevskii, V. N. (Inst. of Physics, Kiev). Zh. Tekh. Fiz.; 40: 711-16(Apr 1970). (In Russian).

Two approaches are used for investigation of the stability of plasma, taking into consideration their dissipative properties. One of the approaches uses the principles of nonequilibrium thermodynamics; the other uses the energetic relations. A series of concrete examples are given. It is shown how the Suydam criterion is transformed for nonideal magnetohydrodynamics. The stability in systems with "crimping" of the curvature of the strong lines of the magnetic field is also investigated. Anywhere this is possible, comparison of the two variational approaches is made. (tr-auth)

40112 EQUILIBRIUM OF PLASMA ELLIPSOIDS IN EXTERNAL HIGH-FREQUENCY FIELD. Khizhnyak, N. A.; Lysenko, O. E. Zh. Tekh. Fiz.; 40: 673-80(Apr 1970). (In Russian).

The problem of the equilibrium of ellipsoidal plasma structure in an external high-frequency field was investigated. It was shown that in order to guarantee the equilibrium of the burst as a whole it was necessary to examine the rotation around the axis of symmetry. The frequency of rotation ω_0 and the effective potential energy U_p, guaranteeing equilibrium, were calculated. Compressed plasma ellipsoids of rotation appeared during this equilibrium. (tr-auth)

40113 BALLOONING MODES IN AXISYMMETRIC TOROIDAL CONFIGURATIONS. Laval, G.; Maschke, E. K.; Pellat, R. (EURATOM–CEA, Fontenay-aux-Roses, France). Phys. Rev. Lett.; 24: 1229-32(1 Jun 1970).

The stability of ballooning modes is investigated in the neighborhood of the magnetic axis of an axisymmetric toroidal configuration of the Tokamak type. It is shown that the stability criterion for these modes is the same as that for localized modes. (auth)

40114 FLUTE-LIKE PLASMA INSTABILITY DRIVEN BY FIELD INHOMOGENEITIES. Voslamber, Dietrich (EURATOM–CEA, Fontenay-aux-Roses, France). Z. Naturforsch.; 25a: 716-23(May 1970).

The stability of ring-like plasma configurations with small Larmor radii, precessing axisymmetrically in mirror machines, is studied. If the precession frequency increases with radius, such equilibria may be subject to a low-frequency flute-like instability driven by field inhomogeneities rather than by the density gradient. The phase velocity of the unstable waves is twice that occurring in the case of the ordinary flute instability. Though the physical situation is quite different from that of circular beams of charged particles, the driving mechanism shows a certain analogy to that of the negative mass instability. It is noteworthy, however, that in the case considered here, equilibria with a finite spread in the transverse particle energies may be less stable than those with zero energy spread. (auth)

40115 THEORETICAL INVESTIGATION OF A TEMPERATURE INSTABILITY IN A MODIFIED PENNING DISCHARGE (Q-PIG). Klan, F. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch.; 25a: 707-15(May 1970).

An instability connected with strong coherent oscillations of the electron temperature as observed in a PIG discharge is investigated theoretically. The energy equation of the electron gas involving the electronic heat flux as well as certain source terms is linearized. A simple dimensional analysis is used in order to avoid more complicated calculations. The stability criterion obtained in this way is evaluated to give a stability boundary in a certain parameter space. It is also found that the temperature perturbation should move with just the $E \times B$ drift velocity of the electrons. The experimental observations agree surprisingly well with the theoretical predictions despite the crude approximations involved. (auth)

40116 AN EXACT NECESSARY AND SUFFICIENT CRITERION FOR THE STABILITY OF INTERCHANGES IN A DIFFUSE, RADIALLY CONSTRUCTED PLASMA BETWEEN ELECTRODES. James, M. K. (Univ. of Adelaide). Aust. J. Phys.; 23: 275-97(Jun 1970).

An exact form of a necessary and sufficient stability criterion is obtained for interchanges in a highly ionized gas discharge, pinched away from the chamber walls and also centrally constricted by the pressure of an external magnetic field of appropriate shape. Using Maxwell's equations and the magnetostatic equilibrium conditions, the mechanical equilibrium of the plasma is briefly examined. It is found that the appropriately chosen curvilinear generalization of the familiar cylindrical geometry does not represent a consistent solution of these two sets of equations, except in the approximation $p \ll \frac{1}{2}B^2$. An end effect that may be important in systems consisting of a highly conducting magnetized plasma bounded by end plates of variable position is discussed, followed by a detailed interchange stability analysis, elaborating an earlier result due to Seymour. In this analysis, Rosenbluth and Langmuir's thermodynamic criterion for the stability of interchanges is applied to the plasma geometry to obtain an analytic expression for the discharge current I_{crit} critical for the onset of unstable interchanges. Important features of this expression are discussed in terms of the components of the curvature vector of the resultant magnetic field lines lying in the discharge surface, and in particular the destabilizing effect of the geodesic curvature for a symmetric system is emphasized. Finally, the expression for I_{crit} is reconciled with the expression obtained earlier by Seymour by showing how the present analysis removes certain approximations made in the earlier work. These approximations are shown to be good for the practical case of a thin discharge with $z_e \gg r_o$, where z_e is the discharge semi-length and r_o the discharge radius at the median plane. (Australia)

40117 PLASMA INJECTION INTO A CURVILINEAR MAGNETIC FIELD. Oya, Keiji; Tanaka, Yuji; Okuda, Takayoshi; Yamamoto, Kenzo (Nagoya Univ., Japan). Kakuyugo Kenkyu; 24: 141-50(Dec 1969). (In Japanese).

The stability of plasma in a curvilinear magnetic field was investigated to make a Tokamak-type magnetic field. A coaxial-type gun was used for a plasma source. The shorting effect of torus drift was produced in the case when the mean free path between electrons and ions is long enough in comparison with the length of plasma column. The electric field caused by the drift was averaged almost uniformly. No Hall conductivity current flows within the plasma in the linear section. At the curvilinear section, the flute instability occurred, but it was stabilized by the finite Larmor radius effect. Then, the density gradient was steep only on the outside of the curvilinear section. Large-amplitude vibrations around 50 to 100 KHz was generated when the magnetic field was intensified, and it can be explained as the drift instability caused by the steep density gradient in that region. (Japan)

40118 ION-WAVE INSTABILITIES AND ANOMALOUS RESISTIVITY. Kan, J. R. (Dartmouth Coll., Hanover, N. H.). Contract NAS 5-9305. Phys. Rev. Lett.; 25: 348-50(10 Aug 1970).

A theory of ion-wave instabilities is presented that takes into account the self-consistent inhomogeneities generated by currents flowing along magnetic field lines. It is found that for $T_e \sim T_i$, the minimum unstable current is reduced from the electron to approximately the ion thermal speed. The result is attributed to the drift-wave instability caused by the inhomogeneities produced by the driving current. (auth)

40119 REMOTE FEEDBACK STABILIZATION OF THE ION-SOUND INSTABILITY BY A MODULATED SOURCE AT THE ELECTRON-CYCLOTRON RESONANCE FREQUENCY. Keen, B. E.; Fletcher, W. H. W. (Culham Lab., Abingdon, Eng.). Phys. Rev. Lett.; 25: 350-3(10 Aug 1970).

Feedback stabilization results are presented for an ion–sound instability. Sensing of the instability was achieved by a photoiodide outside the plasma, and the suppressor element was an electron-cyclotron resonance structure remote from the plasma. Radiation from this structure heats the electrons locally and feedback is achieved by amplitude modulation of the electron-cyclotron resonance at the instability frequency. A theory is developed which predicts the variation of the instability amplitude and frequency in terms of the change in electron temperature ΔT, fractional modulation f, and phase change in the loop, φ. Comparison between theory and experiment shows good agreement. (auth)

Thermonuclear Processes

Refer also to abstract 40517.

40120 (LRP-44/70) NUMERICAL COMPUTATION TO DESIGN A ROTATING FIELD PINCH EXPERIMENT. Weibel, E. S.; Lietti, A. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Jun 1970. 21p. Dep. CFSTI (U. S. Sales Only).

The model proposed is a simple one, describing the dynamics of a rotating-field pinch in terms of the macroscopic quantities: temperature, pressure, plasma radius, and magnetic field strength. The field is obtained by producing oscillating currents in resonant circuits, which are fed by line rf pulse generators. The computation takes into account the equations of the electrical system and of the gas dynamics. The result of this computation is compared with the result of an experiment performed in a 5 × 50 cm discharge tube. The amplitude program, which is necessary in order to confine the plasma in a new experiment on a larger scale, is established. (auth)

40121 (ORNL-TM-3094) THE NEUTRON-INDUCED ACTIVITY AND DECAY POWER OF THE NIOBIUM STRUCTURE OF A D-T FUSION REACTOR BLANKET. Steiner, D. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 16p. Dep. CFSTI.

Calculations of the neutron-induced activity and decay power associated with the niobium structure of a representative D–T fusion reactor blanket are presented. For a 5000-MW (thermal) reactor, after ten years of operation, the induced activity is $\sim 2 \times 10^{10}$ curies and in the long term decays with a half-life of 13.6 years; the decay power is ~50 MW and in the long term decays with a half-life of 35 days. These levels of induced activity and decay power are non-trivial and must be considered in the design requirements of a fusion reactor power plant. (auth)

40122 RESEARCH ON CONTROLLED NUCLEAR FUSION. Pease, R. S. (Culham Lab., Abingdon, Eng.). Riv. Nuovo Cim.; 1: Special No., 184-213(1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

A general survey of fusion research throughout the world and related problems is given. The principles of magnetic confinement in open and closed systems are discussed in terms of the various instabilities present. (M.O.W.)

40123 MAGNETOHYDROSTATIC l = 1, FINITE β STELLARATOR EQUILIBRIUM. Nuehrenberg, Juergen (Institut fuer Plasmaphysik, Garching, Ger.). Phys. Fluids; 13: 1082-8 (Aug 1970).

A finite-β, l = 1 stellarator configuration with tightly wound helical fields and with no longitudinal current through each magnetic surface is determined using a thin-tube expansion. The independent variables are the magnetic surfaces as coordinate surfaces and the magnetic field lines and the current density lines as coordinate lines. The usual thin-tube quantities ρ, φ, and s are treated as dependent variables. The method can readily be applied to other configurations. (auth)

40124 CURRENT SHEET STRUCTURE IN A PARALLEL PLATE RAIL GUN. Pert, G. J. (Univ. of Alberta, Edmonton). Phys. Fluids; 13: 2185-92(Aug 1970).

Experimental measurements of the magnetic and electric field structure in a low-density parallel plate rail-gun discharge are compared with measurements of the electron density and temperature. At a sheet speed of approximately 6 cm/μsec in hydrogen at 0.1 torr it is found that the sheet snowplows the ambient gas throughout the region of observation. The experiments are made at short times (less than the ionization time) after breakdown, and the gas is only weakly ionized. The results indicate that under these conditions a dissociating but nonionizing shock wave precedes the current sheet. The fields and thermodynamic state measurements are shown to be completely self-consistent. (auth)

40125 POSSIBLE MECHANISM FOR THE FORMATION OF FAST PARTICLES IN COAXIAL SOURCES. Belikov, A. G.; Goncharenko, V. P. Zh. Tekh. Fiz.; 40: 764-7(Apr 1970). (In Russian).

On the basis of the analysis of a great quantity of experimental data, a mechanism is proposed for the formation of fast particles in coaxial sources. The results of experiments, verifying the suggested mechanism, are presented. (tr-auth)

40126 MAGNETIC SURFACE MAPPINGS BY STORAGE OI PHASE-STABILIZED LOW-ENERGY ELECTRON BEAMS. Sinclair, R. M.; Hosea, J. C.; Sheffield, G. V. (Princeton Univ., N. J.). Appl. Phys. Lett.; 17: 92-5(15 Jul 1970).

A new technique is described for measuring the shape of a toroidal magnetic field (such as in a stellarator). It is shown that various perturbations do not destroy the magnetic surfaces, but alter their parameters significantly. The same technique can also be used for the long-term storage of low-energy ions. (auth)

40127 CHARACTERISTICS OF A MAGNETIC ENERGY STORAGE SYSTEM USING EXPLODING FOILS. DiMarco, J. N.; Burkhardt, L. C. (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys.; 41: 3894-9(Aug 1970).

A capacitor bank operating at 15 kV and 34 kJ is used to energize an inductive system of 40 nH. Interrupting the current of ~800 kA, by means of an exploding copper foil fuse, produces voltages across the fuse of the order of 80 kV. The opening time of the fuse, as well as the characteristics of the voltage developed across the fuse are examined as a function of the fuse dimensions. If transfer of the current into a matching inductive load is to take place at the time of peak voltage, energy transfer efficiency is of the order of 8% with I's of the order of 2×10^{12} A/sec. (auth)

40128 HIGH-β QUADRUPOLE CONFIGURATION WITH PLASMA CURRENT. Ikuta, Kazunari (Nagoya Univ., Japan). Kakuyugo Kenkyu; 25: No. 3, 138-43(May 1970). (In Japanese).

Quadrupole configurations with a nonuniform plasma current are considered. The configurations are not so much the improvement of Tokamak geometry as the hybrid between ZETA and multipoles. A very deep magnetic well and a strong shear may be realized even in the straight configurations. (auth) (Japan)

40129 ROTATION OF TOKAMAK EQUILIBRIA. Hazeltine, R. D.; Lee, Edward P.; Rosenbluth, M. N. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Lett.; 25: 427-30(17 Aug 1970).

It is found that resistivity causes the self-consistent Tokamak equilibria to be unstable towards rotation about the magnetic axis. The growth rate is $\sim 2\pi^2\eta R^2\beta/\iota^2 a^4$, with η the resistivity, R(a) the major (minor) radius, and ι the rotational transform. This is comparable with the skin penetration rate $\sim\eta/a^2$ of the poloidal field. Simple magnetohydrodynamic theory was employed with resistivity, without considering possible stabilization by other dissipative effects. The quantities η, β, and a/R are regarded as small. This result agrees with one obtained previously in the case of an externally fixed field. (auth)

Wave Phenomena

40130 (D-1-82-965) PINCH OSCILLATIONS IN ELECTRON-HOLE PLASMAS. Chen, Wen S.; Ancker-Johnson, Betsy (Boeing Scientific Research Labs., Seattle, Wash. Plasma Physics Lab.). Apr 1970. 73p.

It is a well-known fact that a strong current can produce pinching of nonequilibrium electron-hole plasmas in InSb. A systematic treatment is given of both theory and observation of pinch oscillations in electron-hole plasmas. The magnetothermal pinch theory, briefly proposed in 1964 by Drummond and Ancker–Johnson, is extended so that quantitative comparison with measurements can be made. The experimental measurements are presented and the results discussed. (M.O.W.)

40131 (KHFTI-69/52) COMBINATION SCATTERING OF MICROWAVES BY LOW-FREQUENCY OSCILLATIONS IN AN ELECTRODELESS INDUCTION DISCHARGE PLASMA. Adamov, I. Yu.; Berezhnyi, V. L.; Dushin, L. A.; Kononenko, V. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1969. 11p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Microwave scattering by low-frequency oscillations in an electrodeless induction discharge plasma was studied, using a superheterodyne receiver operating with fixed frequency and with an adjustable millimeter-range generator. The experimental value of the coefficient of scattering was $\alpha_s \sim 2.5 \times 10^{-9}$ cm^{-1} to 5×10^{-7} cm^{-1}. The refraction of the plasma probing signal showed a high degree of plasma turbulence with density fluctuations $\Delta N/N \sim 0.8 \pm 1$. It is shown that scattering of microwaves took

place on intense longitudinal plasma oscillations propagating almost perpendicularly to the magnetic field with frequencies of $\omega \sim \sqrt{\omega_{Hi} \cdot \omega_{Hi}}$. (tr-auth)

40132 (KHFTI-69/53) CHARACTERISTICS OF COLLISIONLESS DAMPING OF ELECTROMAGNETIC WAVE IN A REGION OF INTENSE INHOMOGENEITY OF A COLD PLASMA. Dolgopolov, V. V.; Omel'chenko, A. Ya. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 15p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Electromagnetic oscillations resulting from the initial perturbations at the boundary of a semi-finite plasma and a vacuum were studied, taking into account the finiteness of the transition region from the homogeneous plasma to the vacuum and, also, an inhomogeneous plane-parallel plasma layer. Three cases are considered: the case in which the length of the wave propagating along the layer is considerably larger than the width of the layer, the case in which the length of the wave is comparable to the width of the layer, and the general case in which there is an arbitrary ratio between the wave length and the width of the layer. (tr-auth)

40133 FINITE AMPLITUDE HELICONS. Igitkhanov, Yu. L.; Kadomtsev, B. B. Zh. Eksp. Teor. Fiz.; 58: 2147-53(Jun 1970). (In Russian).

Inertialess spiral-symmetry oscillations of the electrons of a conductor or plasma in a magnetic field with an arbitrary amplitude are considered. It is shown that ordinary helicons are a particular case of solutions with a frequency that is independent of the amplitude. (auth)

40134 LONGTIME BEHAVIOUR OF A PULSE IN AN UNSTABLE PLASMA. Rowlands, G. (Univ. of Warwick, Coventry, Eng.). Plasma Phys.; 12: 89-93(Feb 1970).

A method of asymptotic expansion is applied to the Vlasov–Maxwell set of equations to determine the characteristics of a pulse propagating in an unstable plasma. The results obtained are identical to those obtained by previous authors using transform methods coupled with the method of steepest descent. (auth) (UK)

40135 DRIFT WAVES IN COLLISIONLESS NONEQUILIBRIUM PLASMAS. Dobrowolny, M. (EURATOM-CNEN, Frascati, Italy); Engelmann, F.; Levine, A. M. Plasma Phys.; 12: 141-2 (Feb 1970).

It is the purpose of this note to discuss explicitly the effect of arbitrary deviations from local thermodynamic equilibrium on the dynamics of drift waves. For simplicity, discussion is limited to cases where these deviations do not drastically alter the qualitative character of the particle distributions, and finite Larmor radius effects are omitted. (UK)

40136 DISPERSION MEASUREMENTS OF ELECTROSTATIC ION WAVES IN A UNIFORM MAGNETIC FIELD. Hirose, A.; Alexeff, I.; Jones, W. D. (Oak Ridge National Lab., Tenn.). Phys. Fluids; 13: 2039-44(Aug 1970).

The phase and group velocities of electrostatic ion waves in a uniform magnetic field were studied experimentally, both as a function of propagation angle (θ) with respect to the field, and as a function of wave frequency. For $\omega \gg \omega_{ci}$, the ion cyclotron frequency, the phase velocity is found to be identical to the ion acoustic velocity $(KT_e/M)^{1/2}$. For $\omega \gtrsim \omega_{ci}$, the electrostatic ion cyclotron mode was observed. The slow mode ($\omega < \omega_{ci} \cos\theta$) was observed to have a constant phase velocity $(KT_e/M)^{1/2} \cos\theta$, in apparent contradiction to theory. The frequency gap ($\omega_{ci} \cos\theta < \omega < \omega_{ci}$), where waves theoretically do not propagate, was demonstrated. (auth)

40137 NONLINEAR DECAY AND INSTABILITY OF A NONUNIFORM FINITE-AMPLITUDE PLASMA WAVE. Porkolab, M.; Chang, R. P. H. (Princeton Univ., N. J.). Phys. Fluids; 13: 2054-63(Aug 1970).

The effects of spatial nonuniformities in the amplitude of a decaying finite-amplitude plasma wave are examined. It is found that the usually neglected, but experimentally important, initial damping (or growth) of the finite-amplitude wave may have important consequencies upon the decay process. The mode-coupling equations are solved for both forward- and back-scattering type decay processes. The latter case is particularly interesting, since both amplification in space, and instability in time, of the perturbed waves may occur in the presence of damping mechanisms. Calculations are presented which show that longitudinal waves with frequencies in the vicinity of cyclotron harmonics may be subject to such instabilities. (auth)

40138 THERMAL CONDUCTIVITY AND LOW FREQUENCY WAVES IN COLLISIONAL PLASMAS. Tsai, Shih-tung; Perkins, Francis W.; Stix, Thomas H. (Princeton Univ., N. J.). Phys. Fluids; 13: 2108-14(Aug 1970).

Thermal fluctuations and heat flow terms are retained in the two-fluid equations used to derive a localized dispersion relation for low-frequency electrostatic waves in a nonuniform collisional plasma. A slab plasma immersed in a uniform magnetic field is assumed. The Nyquist analysis shows two unstable waves: the collisional drift instability and a new overstability of the entropy wave. The collisional drift wave is most easily excited for parallel wavenumbers given by $k_\parallel^2 = 0.15\,\alpha^{7/4} m_e/m_i)^{1/4}$ where $\alpha \equiv |\nabla \ln n|$ (all quantities in cgs units). The stability condition at this $k_\parallel$ is $B/k_\perp < 104\,(m_i n/kT_e|\alpha|)^{1/4}$ G-cm. These are in markedly improved agreement with the experimental data. Heat transport reduces the maximum growth rate, especially at high density. A small equilibrium temperature gradient tends to stabilize the drift waves in the large magnetic field region. The entropy-wave instability propagates along ion drift direction and is found in the range $0.4 \leq \bar{d} \leq 2$ with $\bar{d} \equiv 0.15\,(k_\parallel^2 \kappa T_i/\Omega_i^2 m_i)^{2/3} \nu_{ii} \nu_{ei} m_e/k_\parallel^2 \kappa T_e$. The maximum growth rate of the entropy wave is roughly $k_\parallel (\kappa T_i/m_i)^{1/2} (k_\parallel^2 \kappa T_e/m_i \Omega_i^2)(m_i/m_e)^{1/2}$, and occurs around $\bar{d} = 0.6 \sim 1$. The ion thermal conductivity and temperature gradient are not significant for both instabilities. (auth)

40139 ECHOES AT UPPER HYBRID RESONANCE. I. MEASUREMENTS ON AFTERGLOW PLASMA. Bauer, L. O.; Blum, F. A. (California Inst. of Tech., Pasadena). Phys. Fluids; 13: 2162-73(Aug 1970).

The two-pulse stimulated radiation from nonuniform rare gas (Ar, Ne, He) afterglow plasma columns longitudinally immersed in a uniform (one part in 10^4) magnetic field was studied. For microwave excitation pulses with a center frequency near the maximum upper hybrid frequency of the spatially nonuniform plasma columns, strong two-pulse echoes are observed. A detailed study of these upper hybrid echoes, using an S-band microwave apparatus, is given. At high densities strong echoes are observed shifted from free electron cyclotron resonance by as much as 20%. The conditions for maximum echo follow maximum upper hybrid resonance as the electron density is varied, but are also found to be dependent on the power and time separation τ of excitation pulses. The power and time width of the first echo are shown to have a complex, yet systematic dependence on four major parameters: electron density, magnetic field, excitation power, and τ. The observed behavior is found to be in general qualitative agreement with calculations involving a one-dimensional slab of cold nonuniform collisionless plasma. A study of the effects of neutral gas pressure on certain echo properties indicates that electron neutral collisions do not play any essential role in the echo formation process. Also, some anomalous observations at x band are reported. (auth)

40140 ECHOES AT UPPER HYBRID RESONANCE. II. THEORY FOR A COLD NONUNIFORM PLASMA. Blum, F. A.; Bauer, L. O. (California Inst. of Tech., Pasadena). Phys. Fluids; 13: 2174-84(Aug 1970).

The Lagrangian description of a one-dimensional slab of cold nonuniform plasma in a uniform magnetic field is used to calculate the properties of temporal echoes generated by the application of two electric field pulses. Under weak excitation, the electron plasma acts as an ensemble of uncoupled nonlinear oscillators with amplitude dependent eigenfrequencies, which are the local upper hybrid frequencies $[\omega_c^2 + \omega_p^2(x)]^{1/2}$ in the linear approximation. The decay of the single-pulse response by phase mixing of the oscillators and the action of their nonlinear restoring forces yields, in response to two pulses, a train of echoes in the voltage across the slab. The amplitude of the first echo is studied in detail as a function of magnetic field, electron density, excitation power, and time separation of the excitation pulses. This model successfully accounts for the major features of experimental observations of echoes from afterglow plasmas in a uniform magnetic field. The theoretical echo is strongest in a narrow band of frequencies near the maximum upper hybrid frequency of the plasma slab and shows complex saturation properties in general agreement with experiment. (auth)

40141 NONLINEAR MIXING OF ION ACOUSTIC WAVES IN A PLASMA. Sato, Noriyoshi (Nagoya Univ., Japan). Phys. Fluids; 13: 2198-2200(Aug 1970).

Ion acoustic waves are observed to be generated by nonlinear mixing of Landau-damped ion–acoustic waves excited externally in a plasma. Their damping is interpreted qualitatively by a simple physical argument. (auth)

40142 NONLINEAR GENERATION OF PLASMA WAVES BY BEAMS OF TRANSVERSE WAVES. V. Makhan'kov, V. G.; Tsytovich, V. N. Zh. Tekh. Fiz.; 40: 681-92(Apr 1970). (In Russian).

The instability of a beam of electromagnetic waves relative to the excitation of acoustic oscillations in the plasma, the frequency of which is much less than the frequency of new collisions of the

particles, was investigated. It is shown that two types of acoustic oscillations can be excited. (tr-auth)

40143 NONLINEAR INSTABILITIES OF LANGMUIR WAVES IN THE REGION OF FREQUENT COULOMB COLLISIONS. Makhan'kov, V. G.; Tsytovich, V. N.; Shchinov, B. G. Zh. Tekh. Fiz.; 40: 693-701(Apr 1970). (In Russian).

The effect of double Coulomb collisions on the nonlinear effects in completely ionized plasma (in the range $\omega_- > k_- v_T$) was investigated. It was shown that, in this range, change of the direction of the spectral transfer to conditions of kinetic nonlinear instabilities is possible even for not very intense Langmuir oscillations. The qualitative character of the nonlinear hydrodynamic instabilities of narrow intense Langmuir packets is discussed. (tr-auth)

40144 INTERACTION OF LOW-AMPLITUDE WAVES WITH REAL FREQUENCIES. Ponomarenko, Yu. B. Zh. Tekh. Fiz.; 40: 702-10(Apr 1970). (In Russian).

The effects of the interaction of low-amplitude waves with real frequencies were investigated by the neutralization method. It was found that during long periods of time, the amplitudes of the waves converged towards stationary values, differing little from the initial amplitude (in magnitude of the order of the square of the amplitudes). The difference was determined both as a characteristic of the system and as the distribution of the initial amplitude. The results were applied by hydrodynamic descriptions of the interactions of waves in disordered plasma. It was found that wave conversion processes, forbidden in the hypothesis on the randomness of the phase, were possible. As an example, the propagation of a self-focusing light beam in a nonlinear dielectric was examined. (tr-auth)

40145 THEORY OF PARAMETRIC INSTABILITIES DURING INTERACTION OF PHASED-IN OSCILLATORS WITH PLASMA. Indykul, V. P.; Shevchenko, V. I. Zh. Tekh. Fiz.; 40: 728-32 (Apr 1970). (In Russian).

The interaction of phased-in particles with plasma was investigated. It was shown that, in the presence of phased-in particles in the plasma, instabilities of the parametric type were formed. In particular, unstable longitudinal oscillations at frequencies equal to integers or half-integers of the cyclotron frequency were observed. It was discovered that at frequencies coinciding with integers of the cyclotron frequency, instability of the order of magnitude comparable with beam instability was observed. (tr-auth)

40146 STABILITY OF CYCLOTRON OSCILLATIONS OF RAREFIED PLASMAS, SURROUNDED BY A SURFACE WITH FINITE CONDUCTIVITY OR SURFACE WITH POTENTIAL, CONTROLLING THE SYSTEM OF INVERSE COUPLING. Arsenin, V. V. Zh. Tekh. Fiz.; 40: 748-53(Apr 1970). (In Russian).

Ion cyclotron oscillations of rarefied plasma, surrounded by a surface with finite conductivity, were investigated. Using as examples the perturbation with $k_z \neq 0$ in a cylinder of anisotropic plasma of finite length in cases where the anisotropy of the ion distribution is not too large, and surface waves with $k_z = 0$, it was shown that such a surface can exert a stabilizing effect on oscillations. This possibility of suppressing cyclotron instabilities by means of radiotechnical systems with inverse coupling, controlled by excited fields outside the plasma, is discussed. (tr-auth)

40147 PROPAGATION OF AN ELECTROMAGNETIC WAVE ALONG A PLASMA COLUMN. Camus, Michel (Faculte des Sciences, Paris). Ann. Telecommun.; 24: 309-62(Sep-Oct 1969). (In French).

The basic properties of electromagnetic waves propagated in a homogeneous plasma guide, satisfying the Appleton–Hartree approximation without collisions and in the presence of a uniform longitudinal magnetic induction were investigated. It is shown that some of these properties were predicted by the study of the reflection and refraction of plane waves on surfaces limiting the plasma. Approximate expressions of the dispersion equation of slow waves are given more precisely than those obtained in the quasi-static approximation. A series of experiments lead to the doubting of the hypothesis of the homogeneity of plasmas used in the laboratory to verify the properties cited. By making precise density measurements, it was established that the plasmas effectively have a radial density variation. This inhomogeneity is introduced into the theoretical plasma guide model. Results are then obtained which differ from those predicted by the theory for a homogeneous plasma and which explains the experimental data. (tr-auth)

40148 PROPAGATION OF WAVES ALONG THE MAGNETIC FIELD IN A TWO-COMPONENT WARM PLASMA. Bhatnagar, T. N.; Sharma, S. R. (Univ. of Rajasthan, Jaipur, India). J. Phys., A (London); 404-12(Jul 1970).

Wave propagation along the magnetic field in a two-component warm plasma having arbitrary mass ratio was investigated with the help of moment equations. The equilibrium pressure was assumed to be isotropic. The full-pressure tensor equation (neglecting heat flow tensor) was used, and the effect of momentum and pressure relaxation mechanisms was included in the analysis. The dispersion relations for longitudinal and transverse waves propagating along the magnetic field were derived and discussed in detail. It was found that the pressure relaxation mechanism contributes significantly in the damping of the longitudinal and low-frequency transverse waves. The effect of thermal motion on transverse waves is also discussed. (auth) (UK)

40149 EXCITATION AND DAMPING OF CONTINUOUS PSEUDO-ACOUSTIC AND ION WAVES IN A PLASMA. Takamura, Shuichi; Tanaka, Yuji; Okuda, Takayoshi (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 29: 431-40(Aug 1970).

The continuous sinusoidal pseudo waves excited by a grid were studied experimentally and theoretically. For the small exciting voltage the received signal contains an ion wave. For the large exciting voltage the signal of the pseudo wave is dominant. The velocity of the pseudo wave is given empirically by $\alpha(2eV_{p-\dot{p}}/M)^{\frac{1}{2}}$ The reduction factor α is explained by the transit time effect which occurs when the ions are accelerated by an alternating electric field in the sheath surrounding the exciting grid. It is shown that pseudo waves may be excited even if the damping ratio δ/λ is larger than the value given by Hirshfield and Jacob. The effect of the ion–atom collision and the electric current for waves are studied. The plasma is generated by the funnel-typed source, which is the differentially pumped one for producing a quiescent plasma, and is able to control the various plasma parameters. (auth)

40150 CORRECTION TERM OF LANDAU DAMPING DUE TO TRAPPED PARTICLES. Sugihara, Ryo; Sakai, Jun-ichi (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 29: 447-9(Aug 1970).

An approximate expression for the damping coefficient of an electron plasma wave with a finite amplitude is obtained. It is given in the form, $\gamma_{NL}(\tau) = \gamma_L \{1 - (\bar{E}_0^2/64)[(2/3)\tau^3 - \tau^2 + \tau - (1/2) + (1/2)e^{-2\tau}]\}$ where γ_L and γ_{NL} stand for "the linear and the nonlinear Landau damping coefficients." Here τ and $\bar{E}(\tau)$ are adequately stretched time and electric field, and $\bar{E}_0 = \bar{E}(0)$. The above expression is valid for $\tau \ll \omega_B^{-1}$ where ω_B is the bouncing frequency of electrons trapped in a potential trough of the wave. (auth)

40151 INTERACTION BETWEEN AN ELECTRON WAVE AND AN ION WAVE DUE TO SCATTERING BY ELECTRONS. Nishikawa, Kyoji (California Inst. of Tech., Pasadena). Contract NAS 7-100. J. Phys. Soc. Jap.; 29: 449-58(Aug 1970).

Some basic properties of the coupling between an electron wave and an ion wave due to scattering by thermal electrons are discussed by comparing them with those of the coupling due to three-wave interactions. Using the kinetic wave equation which describes the relevant wave–particle interaction, the following three special problems are discussed in detail: (1) effect of an enhancement of short-wavelength ion-wave fluctuations on the long-wavelength electron waves; (2) effect of an enhancement of long-wavelength electron waves on the short-wavelength ion waves; and (3) effect of the beam-excited short-wavelength electron waves on the long-wavelength ion waves. (auth)

40152 STUDY OF THE IONIZATION RATE VARIATIONS IN THE IONIZATION WAVES IN PLASMAS. II. Sicha, M. (Charles Univ., Prague); Rezacova, V.; Drouet, M. G. Czech. J. Phys.; 20: 770-5(1970).

Measurements of the plasma potential variation in fast "r" type ionization waves are presented. The phase of the ionization rate variations is calculated on the basis of this experiment and experimental results obtained later. The advantage of the calculation presented is that it does not contain the variation of the electron mean energy. Therefore, no preliminary assumptions about the nature of the electron distribution function and about its variation are necessary. (auth)

40153 EXPLOSIVE INSTABILITY OF INTERACTING WAVES IN QUIESCENT PLASMA. Karplyuk, K. S.; Oraevskii, V. N.; Pavlenko, V. P. (Inst. of Physics, Kiev). Ukr. Fiz. Zh.; 15: 859-61(May 1970). (In Russian).

Nonlinear interactions of three waves with positive and negative energies are studied. Accurate analytical equations are obtained, describing evolution of interacting wave amplitudes. Dynamics of nonlinear waves with positive and negative energies for the case of longitudinal waves propagating along the electron stream penetrating through an isotropic plasma are described by two-fluid hydrodynamics and Maxwell equations. Data obtained indicate that

the time of developing explosive instabilities in the quiescent plasma is of the order of magnitude $\sqrt{T(E)^2}$ less than the corresponding time in turbulent plasma. (R.V.J.)

40154 INTERPRETATION OF AN EXPERIMENT ON THE ANOMALOUS ABSORPTION OF AN ELECTROMAGNETIC WAVE IN A PLASMA. Kaw, P.; Valeo, E.; Dawson, J. M. (Princeton Univ., N. J.). Phys. Rev. Lett.; 25: 430-3(17 Aug 1970).

An interpretation is given of a recent experiment on the anomalous absorption of a powerful electromagnetic wave in a collisionless plasma. The electromagnetic wave excites an instability, driving up the ion-density fluctuations. The ion waves scatter energy efficiently from the electromagnetic wave into longitudinal plasma modes which are then absorbed in the plasma. (auth)

40155 NONLINEAR INTERACTION BETWEEN POSITIVE-ENERGY AND NEGATIVE-ENERGY WAVES IN A DISPERSIVE MEDIUM. Agu, Masahiro (Tokyo Inst. of Tech.). J. Phys. Soc. Jap.; 29: 468-78(Aug 1970).

The full description of the nonlinear interaction between positive- and negative-energy waves in a dispersive medium is derived with the use of the concept of quasi particles. The generalized Manley-Rowe relations in terms of the occupation numbers (actions) of positive- and negative-energy quasi particles (waves) are obtained in a dispersive medium. The extended rate equations are also obtained that describe the temporal and spatial variation of the numbers of quasi particles. As an interesting case for the nonlinear negative-energy instability, the three-wave interaction is discussed in which a signal wave excited by a pumping wave has a convective or an absolute instability with the help of a negative-energy idler wave. (auth)

Shielding

Refer also to abstracts 39728 and 40302.

40156 (AEEW-R-675) THE IMPORTANCE OF BREMSSTRAHLUNG IN THE SHIELDING OF GAMMA RAYS HAVING ENERGIES LESS THAN 10 MeV. Dutton, L. M. C. (Atomic Energy Establishment, Winfrith (England)). Oct 1969. 76p. Dep. CFSTI (U. S. Sales Only). UK 9s. 6d.

Using Monte Carlo techniques the bremsstrahlung contribution to the dose rate due to 10- and 6-MeV photons incident on lead and iron shields was evaluated for thicknesses up to 20 mean free paths. The photon energy spectrum on the outside of several shield thicknesses was also determined. The bremsstrahlung energy distribution and that of pair-produced electrons were derived, using the Born Approximation formalism, and the validity of the latter to the present calculation is discussed. The bremsstralung angular distribution and that of pair-produced electrons was assumed to be perfectly forward peaked, but the validity of this assumption is discussed and the distributions calculated in typical cases. It is found that the bremsstrahlung contribution doubles the dose rate at large penetrations for the case of 10-MeV photons incident on lead shields, but in the other cases considered it never exceeds 20% of the dose rate obtained if bremsstrahlung is neglected. (auth) (UK)

40157 THERMAL UTILIZATION FACTOR OF A SLAB LATTICE HAVING LINEARLY ANISOTROPIC SCATTERING. Mai, W. (VEB Kraftwerksanlagenbau, Berlin). Kernenergie; 13: 105-16(Apr 1970). (In German).

The thermal utilization factor for a slab lattice is determined, starting from the monoenergetic Boltzmann equation in terms of linearly anisotropic scattering. The Fourier transform method developed by Kiesewetter has been used as the solution formalism. The system of singular intergral equations coming from this has not been solved, and the solutions of this system have been suggested to be well-known in the further calculations. Numerical results have not yet been given, they will be published in a further paper. (auth)

40158 INELASTIC SCATTERING OF THE FINITE-CROSS-SECTION PARTICLE BEAM. Ostroukhov, A. A. (Inst. of Problems in Material Studies, Kiev). Ukr. Fiz. Zh.; 14: 2070-3(Dec 1969). (In Russian).

Previously, equations that describe the statistical motion of inelastically scattered particles were derived for the case in which an unlimited homogeneous beam of primary particles falls upon an infinite layer of a material with a finite thickness. This study is extended here by deriving similar equations for a primary particle beam of a finite diameter; an expression is also obtained for the energy released by the beam in a unit volume, using again, as in the earlier work, the continuous energy loss approximation. The formula obtained allows one to calculate all particles that may reach a point M in a given volume element $d\tau$, lying at a certain distance from it in volume element $d\tau'$, at point M'. Summation of the equation yielded the amount of the total energy released by the beam in a unit volume. (TTT)

Solid-State Physics

Refer also to abstracts 40547 and 40564.

40159 SOLID-STATE PHYSICS: ADVANCES IN RESEARCH AND APPLICATIONS. VOLUME 23. Seitz, Frederick; Turnbull, David; Ehrenreich, Henry. New York; Academic Press Inc. (1969). 531p. $25.00.

Four reviews are presented, namely: effects of electron-electron and electron-phonon interactions on one-electron states of solids (by L. Hedin and S. Lundqvist), theory of dilute magnetic alloys (J. Kondo), localized moments and nonmoments in metals: the Kondo effect (A. J. Heeger), and physics of quantum crystals (R. A. Guyer). (D.L.C.)

Radiation Effects

Refer also to abstracts 38969, 39241, 39292, 39294, 39295, 39298, 39842, 40517, 40579, and 40619.

40160 (ORNL-TM-3013) PRODUCTION OF DISPLACEMENT DAMAGE BY LIGHT IONS. King, R. T. (Oak Ridge National Lab., Tenn.). Jul 1970. Contract W-7405-eng-26. 26p. Dep. CFSTI.

The rates at which atoms are displaced from normal lattice positions by protons and α particles are calculated as functions of ion energy for aluminum, copper, stainless steel, and molybdenum. Ion-bombardment experiments cannot completely simulate neutron irradiations. Light-ion bombardment experiments are useful for screening alloys by electron microscopy for irradiation stability. (auth)

40161 RADIATION DAMAGE, ANNEALING, AND THERMAL DESORPTION IN TUNGSTEN INDUCED BY LOW ENERGY Ar^+ ION BOMBARDMENT. Navinsek, B. (Inst. Josef Stefan, Ljubljana, Yugoslavia. Univ., Ljubljana, Yugoslavia); Marinkovic, V.; Osredkar, M.; Carter, G. Radiat. Eff.; 3: 115-21(May 1970).

Prethinned foils of polycrystalline tungsten (over 70% of transparent grains had (100) orientation or very near to it; other grains had (113) and (111) orientations) have been bombarded with 4-keV Ar^+ ions. The ion doses varied from 2×10^{15} to 5×10^{17} ions/cm^2. Electron microscope observations have shown that the intensity of damage in the form of large defect clusters, dislocations, complex dislocation tangles, and networks increased with ion dose, but a "saturation" effect was found at doses of 1 to 2×10^{17} ions/cm^2. The concentration of damage depends on the crystallographic orientation of the grains. The maximum damage density was found in grains with (100) orientation at all bombardment doses. In (100) oriented grains, a tendency for alignment of radioinduced dislocation loops was found. These row formations were parallel to the (110) direction. The development of such alignment depends on ion energy, flux, and dose, and it is closely connected with surface and crystal structure. For annealing studies, temperatures of 650, 900, 1200, 1500, and 2000°C were used. These temperatures have been shown to represent the desorption peak temperatures for tungsten, obtained under similar bombardment conditions as used in the present study. While the annealing of damage at 650°C (one hour in a vacuum better than 10^{-7} torr) produced some effect only at the highest doses, heating one hour at 900°C had a remarkable effect even for ion doses lower than 1×10^{17} ions/cm^2. The main maximum in thermal desorption spectra at temperatures around 1200°C agrees very well with the most intense annealing of damage in tungsten. Correlation of the annealing process in ion-bombarded tungsten with thermal desorption spectra helps to explain the processes occurring in tungsten connected with low-energy ion bombardment, namely damage formation, thermal desorption, and annealing of damage. Evidence of high damage density in tungsten at different ion doses and low ion energies suggests that the radiation damage model for desorption and the analysis of the results given earlier were correct. The results agree with the annealing studies of damage in other bcc metals. (auth)

40162 DEFECT MOBILITY AND REACTION: DIFFUSIONAL AND RATE THEORY FORMULATIONS IN ONE AND THREE DIMENSIONS. Simpson, H. M.; Sosin, A. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-1800. Radiat. Eff.; 3: 1-21 (May 1970).

The migration of defects, leading to eventual reaction, is analyzed on the basis of diffusion theory and compared with chemical rate theory. A diffusional treatment is carried out in detail and in

special cases of particular interest. Correlations between interstitials and vacancies, typical of metals following electron irradiation, are examined. Trapping by impurities and dislocations, thermal conversion, and high-temperature bombardment are also treated. In each case, formulations are developed along both one- and three-dimensional diffusion models. These alternative results are compared with experiments, particularly annealing in copper irradiated by electrons at low temperature. The results support the conclusion that the defect that migrates in Stage I diffuses in three dimensions. (auth)

40163 SPUTTERING EFFICIENCY OF POLYCRYSTALLINE SOLIDS. Andersen, H. H. (Danish Atomic Energy Commission Research Establishment, Risoe, Denmark). Radiat. Eff.; 3: 51-9(May 1970).

The sputtering efficiency (i.e., the ratio of reflected to incident energy) was measured for graphite, aluminum, silicon, copper, silver, tantalum, and lead with 30- to 75-keV He^+, C^+, Ne^+, Ar^+, Cu^+, Kr^+, Xe^+, and Pb^+ ions at perpendicular incidence. The measured efficiencies range from 0.5% (He^+ — Si) to 7% (Ne^+ — Pb). In accordance with theory, the results for heavier projectiles may be represented as a function of the ratio of target-to-projectile masses M_2/M_1 only. The results are either energy-independent or they decrease with increasing energy, the energy dependence being more pronounced the lighter the targets and projectiles. (auth)

40164 CARRIER CONCENTRATION, MOBILITY, RESISTIVITY, AND IMPURITY CONCENTRATION OF 400 keV CHANNELED PHOSPHORUS IONS IN SILICON. Johansen, A. (Univ. of Copenhagen); Olsen, J. S.; Sarholt-Kristensen, L.; Martin, F. W. Radiat. Eff.; 3: 65-72(May 1970).

High-resistivity single crystals of p-type silicon were implanted at room temperature in the ⟨110⟩ direction with 400-keV ^{31}P and ^{32}P ions, using total doses of 10^{13} and 10^{15} ions/cm^2. Hall-effect measurements on samples annealed to 600°C, combined with peeling techniques were used to determine the surface carrier concentration and effective mobility as a function of depth (in 0.2-μ steps), and also as a function of measurement temperature (300 to 88°K). From these measurements, the bulk carrier concentration and mobility were computed. The conductivity and carrier concentration distributions for samples implanted with 10^{15} ions/cm^2 have a large "random" peak at 0.5 μ depth and a "channeled" peak at 1.6 μ. The distribution of radioactive ^{32}P atoms also shows the prominent random peak and extends as far as 1.6 μ. The carrier concentration of 10^{19} cm^{-3} at any temperature indicates that impurity banding is present in the random peak. A corresponding decrease in mobility is observed. From the temperature dependence of the carrier concentration at other depths, estimates of the donor density and compensating acceptor density are obtained. In the channeled region, a donor density of 2×10^{17} cm^{-3} and a compensation ratio of 0.2 are estimated. (auth)

40165 ION BOMBARDMENT INDUCED PHASE TRANSFORMATIONS AND INERT GAS MOBILITY IN THE SEMICONDUCTORS Ge, Si, AND GaAs. Matzke, Hj. (CCR-EURATOM: Ispra, Italy). Radiat. Eff.; 3: 93-105(May 1970).

This study contributes some new aspects to the general understanding of the ion implantation behavior of three common semiconductor materials and of diffusion processes in these materials. Single crystals of Si, Ge, and GaAs were bombarded with Kr or Xe ions at energies of 40 to 500 keV and doses between 10^{11} and 2×10^{16} ions/cm^2. Gas-release measurements and Rutherford scattering of 1-MeV He^+ ions combined with channeling were used to study bombardment damage (amorphization) and inert gas diffusion. At low bombardment doses (10^{11} ions/cm^2) and energy (40 keV), no damage was observed and the gas release was compatible with volume diffusion resembling Group I and VIII behavior. Hence, the pre-exponential terms, D_0, were low (range 10^{-5} to cm^2 sec^{-1}) and the activation enthalpies, ΔH, were much lower than those of self-diffusion or of diffusion of Group III and V elements. The ΔH's for gas diffusion followed the relation $\Delta H = (1.05 \pm 0.1) \times 10^{-3}\ T_m$ eV with the melting point, T_m, in °K. The mechanism of gas mobility might be the Turnbull dissociative mechanism. Rutherford scattering and channeling data indicated that part of the gas occupied lattice sites. At higher doses, the bombarded layers turned amorphous. Channeling experiments showed a coincidence in temperatures for a gas release process different from the above one of volume diffusion, and recrystallization of the disordered layer to the single crystalline state. Both processes occurred in the temperature range 0.60 to 0.65 T_m. The gas release indicated a (partial) single jump character with implied ΔH's following the relation $\Delta H = (2.1 \pm 0.1) \times 10^{-3}\ T_m$ eV. Contrary to previous results on oxides, this new gas release occurred at temperatures near to those or even above those of volume diffusion of the gas. Due to the easy formation of an amorphous layer, it was difficult to observe the retarded release (trapping of gas) that has been found in many materials at high gas and damage concentrations. However, in a separate series of experiments with 500-keV Kr ions, a release retarded with respect to volume diffusion of the gas was observed in Si and Ge. (auth)

40166 RADIATION DAMAGE ENHANCED TRAPPING OF LOW-ENERGY He^+ IONS IN RHENIUM. Davies, A. L. M.; Carter, G. (Univ. of Salford, Eng.). Radiat. Eff.; 3: 107-13 (May 1970).

A polycrystalline rhenium target was bombarded in ultrahigh vacuum at room temperature with low-energy Ar^+ and He^+ ions. The ions retained in the solid were desorbed into a closed volume by raising the target temperature linearly, with respect to time. The differential signal in a mass spectrometer provided desorption spectra, and trapping coefficients were estimated. The behavior was found to be similar to that observed in other metals. In the case of He^+ ion bombardment, the damage state of the target prior to injection was varied by pre-bombarding with Ar^+ ions. It was found that this damage considerably increased the amount of helium trapped: the trapping was predominantly at defects caused by the pre-bombardment. Helium was released at temperatures characteristic of the release of the argon, which caused the damage. The helium thus traced the damage present in the target prior to bombardment. (auth)

40167 TRAPPING AND RE-EMISSION OF FAST DEUTERIUM IONS FROM NICKEL. II. Erents, K.; McCracken, G. M. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Radiat. Eff.; 3: 123-9(May 1970).

Experiments on deuterium bombardment of nickel were continued, and measurements of gas release during and after bombardment were compared. The results are consistent with the hypothesis that gas release from the solid is controlled by radiation damage sites produced by the incident ions slowing down in the metal. The population of these damage sites as a function of incident ion dose was deduced. (auth)

40168 SPUTTERED ATOM EJECTION PATTERNS FROM Ge. MacDonald, R. J. (Australian National Univ., Canberra). Radiat. Eff.; 3: 131-6(May 1970).

Previous studies of the sputtered atom ejection patterns from Ge (100) surfaces suggested the existence of a ⟨111⟩ focusing mechanism in the diamond lattice. These experiments were extended to a study of the ejection patterns from Ge (111) and (110) surfaces. No preferential ejection along the ⟨111⟩ direction was observed from these surfaces. When the reconstructed surface models suggested by low-energy electron diffraction are used, the analysis of collision sequences suggests that the only reconstruction likely to defocus ⟨111⟩ collision events will occur in the case of the (100) surface. All the ejection patterns reflect the surface symmetry. A crystallographic dependence of the transition temperature for annealing of the ion bombardment-induced damage was detected. (auth)

40169 ENHANCED OXIDATION ON ION-IMPLANTED SILICON. Meyer, O.; Mayer, J. W. (California Inst. of Tech., Pasadena). Radiat. Eff.; 3: 139-40(May 1970).

Enhanced oxidation was found to occur on ion-implanted Si during anneals at 600 to 1100°C. Implantations of Rb, Cs, Cd, I, Se, and Sb were carried out at 50 keV, and analyses were carried out using backscattering of 1-MeV ^4He ions. The amount of oxidation depends on the implanted species (being greatest for Rb and I) and, in some cases, the ion dose. A graph of oxidation vs anneal temperature is presented. (D.L.C.)

40170 INVESTIGATION OF A LOCAL MAXIMUM OF THE SCINTILLATION LIGHT YIELD OF ANTHRACENE SINGLE CRYSTALS EXCITED BY α PARTICLES. Kleinert, Gero. (Univ., Goettingen, Ger.). Z. Phys.; 236: 250-9(1970). (In German).

The scintillation light yield of anthracene single crystals excited by 8.78-MeV α-particles and its dependence on particle-impact direction is investigated. Special attention is paid to a local maximum of the scintillation light yield first observed by Kiensle. The local maximum is found to occur exactly in the (a,b) plane. This is confirmed in the temperature range from 14 to 90°K. According to a theory of Boensch, this local maximum is explained by anisotropic diffusion of triplet excitons. In the interpretation of the local maximum, channeling effects should be excluded. (auth)

40171 EFFECT OF NUCLEAR RECOIL ON THE INTERMEDIATE-STATE REORIENTATION OF ORIENTED NUCLEI. Misra, Sushil K. (Sir George Williams Univ., Montreal). Phys. Rev., B; 1: 63-9(1 Jan 1970).

The effect of a dynamic mechanism, namely, nuclear recoil, on the reorientation of oriented nuclei is treated via a model system. This system consists of a nucleus belonging to an iron-group ion X in an XY_3Z complex possessing C_{3v} symmetry. The numerical results clearly indicate that the nuclear recoil may become an im-

portant mechanism for reorientation when (i) there is no inversion symmetry and (ii) the electronic spin of the ion containing the nucleus is greater than ½, allowing for the presence of S^3q terms in the electron spin–vibrational coupling. For the particular examples considered, values of attenuation ranging from –27% to +73% were found. (auth)

40172 CHANNELING EFFECTS IN THE LIGHT YIELD OF ANTHRACENE, NAPHTHALENE, AND p-TERPHENYL CRYSTALS EXCITED BY α PARTICLES. Boensch, G.; Flammersfeld, A. (Univ., Goettingen, Ger.). Z. Phys.; 236: 305-13(1970). (In German).

The scintillation light yield of anthracene at 300°K and 80°K and of naphthalene and p-terphenyl at 80°K was investigated for impact directions in the (a,c)-plane. The light yield was measured for well-defined integration times. The relative depth of the channeling minimum observed for impact directions parallel to the c-axis of anthracene is found to increase with increasing integration times. For the first time, channeling minima of the light yield were observed at impact directions parallel to the c- and the [102]-axis of naphthalene and the c- and [$\bar{1}$02]-axis of p-terphenyl. The [$\bar{1}$02]-axis of p-terphenyl shows a more pronounced effect than the c-axis. (auth)

40173 PROTON BOMBARDMENT INDUCED CONDUCTIVITY IN ANTHRACENE SINGLE CRYSTALS. Huber, W.; Scharmann, A. (Univ., Giessen, Ger.). Z. Phys.; 236: 383-402(1970). (In German).

Transient currents in anthracene crystals were measured under bombardment by pulses of 700-keV protons. Electron–hole pairs are generated by an intrinsic process, the yield varying linearly with the intensity of the bombarding beam. The average energy for pair production is found to be 10^4 eV. The temperature dependence of the carrier yield can be characterized by an activation energy of 0.07 eV. The results are discussed with regard to different models of the generation process. Drift mobilities of 0.46 cm^2/V sec for electrons and 0.88 cm^2/V sec for holes are determined in good agreement with other authors. A reduction of the current pulse height with the number of bombarding pulses is observed and explained in analogy to the known deterioration of luminescence under ion bombardment. Thereby, the higher deterioration constant for the conductivity can be understood. (auth)

40174 DEPENDENCE OF PULSED-RADIATION-INDUCED CURRENT UPON DIRECTION OF APPLIED ELECTRIC FIELD IN CRYSTALLINE QUARTZ. Okabe, Shigeru; Tsumori, Kunihiko; Tabata, Tatsuo; Kawabata, Keisuke; Yoshida, Toshio. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 31-3(1969).

Pulse shapes of the radiation-induced current in crystalline quartz were observed by using the pulsed electrons from a linear accelerator. The variation with time of the pulsed-radiation-induced current was found to be dependent on direction of the applied electric field with respect to the crystal axes, and the dependence on direction of the incident 13-MeV electron beam was not appreciable. (auth)

40175 CHARGED SCATTERING CENTERS IN ELECTRON-IRRADIATED CdS. Kitagawa, Michiharu; Yoshida, Toshio; Shono, Yoshihiko. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 50-4(1969).

The change of electrical conductivity σ, carrier concentration n, and Hall mobility μ_H of conduction electrons in highly conductive CdS irradiated by 10-MeV electrons were studied experimentally. Total integrated dose of irradiation was 4×10^{15} electrons/cm^2. The carrier concentration increases and the Hall mobility decreases rapidly at the beginning of irradiation, and then both decrease gradually as irradiation dose increases. It may be considered that the excited electrons accumulate in the conduction band and excited holes are captured by trapping centers in the 1st stage, and changes in the 2nd stage are caused by the production of the defects. Increased density in the charged centers is calculated by the Conwell–Weiskopf formula, after considering the temperature-dependence curves of μ_H before and after irradiation. The calculated density ΔN_{ch} is unexpectedly large compared with carrier concentration ($\Delta N_{ch} \simeq 5 \times 10^{16}$). Introduction rate of charged centers is estimated to be nearly equal to or slightly larger than 10. (auth)

40176 ELECTRON SPIN RESONANCE OF ELECTRON-IRRADIATED ZnS. Shono, Yoshihiko; Kitagawa, Michiharu; Yoshida, Toshio. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 55-8(1969).

Two new signals, the signals G and H, were found in ZnS crystal irradiated with 8-MeV electrons in the stream of cold nitrogen gas. The signal G was large while the signal H was small immediately after the electron irradiation. The signal G was excited with the light of the wavelength shorter than 440 mμ and quenched with visible light. From the change of the intensity of the signal G with that of the signal H it is considered that the defects responsible for the signal G associate with impurities or other defects while they are migrating in the crystal, and are changed into new complex defects responsible for the signal H. This defect has an axial symmetry and the symmetry axis of the [111] crystal axis. The structure of it is considered to be similar to that of A center. (auth)

40177 CHANNELING OF α PARTICLES IN ANTHRACENE, p-TERPHENYL, AND LITHIUM FLUORIDE MONOCRYSTALS. Amberger, R. Wolfgang (Univ., Goettingen, Ger.). Z. Phys.; 236: 352-61(1970). (In German).

Channeling of 8.79-MeV α particles in monocrystals of anthracene, p-terphenyl, and lithium fluoride was studied in transmission experiments at T = 130°K. For LiF, the measurements were were performed at room temperature as well to show the temperature dependence of the transmitted particle spectra. Critical angles were measured for the [001] axis of anthracene, the [$\bar{1}$02] axis of p-terphenyl, and the three main axes of lithium fluoride. (auth)

40178 ESR AND OPTICAL ABSORPTION SPECTRA OF IRRADIATED BORATE GLASSES CONTAINING TITANIUM. Arafa, S.; Bishay, A. (American Univ., Cairo). Phys. Chem. Glasses; 11: No. 3, 75-82(Jun 1970).

The ESR and optical absorption spectra of unirradiated and γ-irradiated calcium borate glasses containing titanium of a mol % composition (70 – x) B_2OC, 30CaO, x TiO_2 were studied. In unirradiated glasses melted under reducing conditions, an intrinsic optical absorption band at about 2.5 eV (and a shoulder at about 1.6 eV) as well as an ESR line at g ≃ 1.942 were observed and attributed to Ti^{3+} ions considered to be present in an octahedral symmetry with tetragonal distortion. Irradiating the samples melted under reducing conditions caused a decrease in the intensity of the four-line resonance characteristic of the irradiated base glass containing no titanium. On the other hand, the opposite effect was observed with glasses melted in air under normal conditions (containing Ti^{4+} ions). Similarly, the induced visible absorption characteristic of the irradiated base glass was weaker in the glasses containing titanium and melted under reducing conditions and stronger in the corresponding glasses melted under normal conditions. (auth) (UK)

40179 MOESSBAUER EFFECT METHODOLOGY. VOLUME 5. Proceedings of the Fifth Symposium, New York, February 2, 1969. Gruverman, Irwin J. (ed.). New York: Plenum Press (1970). 284p. $19.50. (CONF-690221).

Separate abstracts were prepared for 7 of the articles. (M.O.W.)

For abstracts of individual papers see: 40194–40200.

40180 MONOVALENT EUROPIUM CENTERS IN KI. Varenko, G. D.; Avdonin, V. P.; Zazubovich, S. G.; Plachenov, B. T. Opt. Spectrosc. (USSR) (Engl. Transl.); 28: 153-5(Feb 1970).

Translated from Opt. Spektrosk.; 28: 284-8(Feb 1970).

A study was made of the luminescence with λ_{max} = 480 nm in KI: Eu; the conditions of the formation of these centers are investigated in detail, along with the mutual conversions of luminescence centers of Eu^{2+} and "480" centers into one another, and also the polarization characteristics of the luminescence. It was concluded that additive coloration or exposure to ionizing radiation of alkali halide crystals activated by Eu^{2+} leads to the formation of anisotropic centers containing Eu^+ entering into the composition. It is proposed that these centers are Eu^+ ions at cation lattice sites, associated with some point defect situated in the direction of the C_4 axes of the crystal. (auth)

Physical Properties

Refer also to abstracts 39648–39650, 39671, 39704, 39706–39711, and 39845.

40181 (IN-1317, pp 153-208) MATERIALS. (Idaho Nuclear Corp., Idaho Falls).

ARGON ISOTOPES ^{36}Ar—neutron inelastic scattering spectra by liquid
—^{38}Ar–^{40}Ar, neutron inelastic scattering spectra by liquid
ARGON ISOTOPES ^{40}Ar—^{36}Ar–^{40}Ar, neutron inelastic scattering spectra by liquid
BENZENE—ring bending modes in, neutron inelastic scattering study
BISMUTH—neutron diffraction patterns of II and high-pressure III phases of
CRYSTALS—valence force model with cell-dipole approximation for long-range forces
CYANOGEN BROMIDES—dispersion relation calculations

ETHANE—torsional vibration in liquid, neutron inelastic scattering study
MOLECULES—group rotations in atomic displacement calculations, transformation for rigid
NEUTRON CHOPPERS—use of statistical, in phonon measurements on small crystals
NEUTRONS—scattering by liquid argon-36 and argon-36–argon-40, spectra of inelastic
—scattering by organic molecules in molecular spectroscopy, inelastic
PROPANE—torsional vibrations of methyl radicals in gaseous, liquid, and solid, neutron inelastic scattering study
—torsional frequency calculations, errors in rigid-frame approximation
PROPANE, 2,2-DIMETHYL—torsional vibrations in gaseous, liquid, and solid, neutron inelastic scattering study
PROPANE, 2-METHYL—torsional vibrations of methyl radicals in gaseous, liquid, and solid, neutron inelastic scattering study
SILICON—valence force potentials for dispersion relation calculations
SODIUM CHLORIDES—Debye temperature of, pressure dependence of
—phonon measurements on small crystals of, using statistical chopper
THALLIUM—dispersion relations at 80 and 300°K for symmetry directions [0001] and [01$\bar{1}$0]
VANADIUM OXIDES—thermal expansion and compressibility of V_2O_5, pressure dependence of
o-XYLENE—torsional frequency calculations, errors in rigid-frame approximation
ZIRCONIUM—phonon dispersion relations (D.L.C.)

40182 (IS-T-356) THE RADIO-FREQUENCY SIZE EFFECT AND THE FERMI SURFACE OF MOLYBDENUM. Cleveland, Joseph Robert (Ames Lab., Iowa). May 1970. Contract W-7405-eng-82. 127p. Dep. CFSTI.

Thesis.

The radio-frequency size effect was used to determine Fermi surface caliper dimensions in the (110) plane for molybdenum. The apparatus used to detect the rf size effect resonances measured the induced frequency changes of a variable-frequency oscillator by means of field-modulation techniques. The detection properties of this type of apparatus are analyzed by considering the electrodynamics of the sample and tank coil system. It is demonstrated that significant signal-to-noise ratio enhancement can be achieved by means of detecting the frequency-modulated rf signal at a harmonic of the fundamental frequency of the variable-frequency oscillator. The sensitivity of the apparatus used in this investigation was such that fractional changes in the fundamental frequency of 1×10^{-9} could be detected. The rf size effect measurements were made on flat plates of molybdenum with residual resistance ratio of 5000. Studies of the resonance line width vs frequency permitted an accurate determination of the resonance magnetic field values. From these measurements, very accurate Fermi surface dimensions along major crystallographic directions were determined. These results are compared with recent theoretical and experimental work on molybdenum. From the Fermi surface dimensions of the electron "jack" and the hole "octahedra" along H, the separation between these two Fermi surface pieces is estimated to be $\Delta K = 0.149 \pm 0.014$ A^{-1}, which is 7% of the ΓH distance. The indicated uncertainty in the gap dimension represents a 90% confidence limit. On the basis of this value for the gap, the spin–orbit coupling parameter for molybdenum is estimated to be 0.03 Ry. (auth)

40183 (ORNL-4446, pp 177-96) INTERACTION OF RADIATION WITH LIQUIDS AND SOLIDS. Arakawa, E. T.; Birkhoff, R. D.; Braundmeier, A. J. Jr.; (and others) (Oak Ridge National Lab., Tenn.).

ALUMINUM—photoelectric properties of films of, effects of contamination on
—spectra of electron-bombarded films of, emission
—spectra of coatings on diffraction gratings, surface plasmon resonance effect in
BENZENE—optical properties of pure liquid, volume plasma resonance in
DIFFRACTION GRATINGS—spectra of metal coatings on, surface plasmon resonance effect in
GOLD—spectra of coatings on diffraction gratings, surface plasmon resonance effect in
HEXANE—optical properties of pure liquid, single-electron excitations in
MAGNESIUM—photoelectric properties of films of, effects of
POLARISCOPY—extinction azimuth calculations as function of optical constants in ultrahigh vacuum ellipsometry
POTASSIUM—dielectric constant of, imaginary part of, (E)
RUBIDIUM—refractive index of films of, (E)
SILVER—spectra of coatings on diffraction gratings, surface plasmon resonance effect in
SODIUM—dielectric constant of, imaginary part of, (E) (D.L.C.)

40184 USE OF NEUTRONS IN THE STUDY OF SOLIDS AND LIQUIDS. Marshall, W.; Lovesey, S. W. (Atomic Energy Research Establishment, Harwell, Eng.). Riv. Nuovo Cim.; 1: Special No., 155-73(1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

A few examples of studies utilizing the technique of neutron scattering, primarily inelastic scattering, are considered. (L.M.T.)

40185 STUDIES OF URANIUM MONOPHOSPHIDE AND ITS SOLID SOLUTIONS WITH URANIUM MONOSULPHIDE. Allbutt, M.; Dell, R. M.; Junkison, A. R.; Marples, J. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem.; 32: 2159-68(Jul 1970).

Magnetic susceptibility measurements from 100° to 1000°K were made on UP and on the solid solutions $UP_{0.25}S_{0.75}$, $UP_{0.5}S_{0.5}$ and $UP_{0.75}S_{0.25}$. Further measurements on compositions closer to the UP end of the binary confirm and extend earlier results. Antiferromagnetic ordering is observed for solid solutions containing ≤10% and ferromagnetic ordering for ≥25% US. Electrical resistivity and x-ray lattice parameter measurements as a function of temperature are reported for the 3 principal compositions. The resistivities show a change of slope at the Curie points. The structural behavior is more complex; $UP_{0.25}S_{0.75}$, like US, undergoes a rhombohedral distortion below the Curie point but reverts to cubic below 45°K. Neither $UP_{0.5}S_{0.5}$ nor $UP_{0.75}S_{0.25}$ shows this behavior but the latter composition undergoes a small change in lattice parameter near 17°K. (auth) (UK)

40186 DENSITY OF STATES INFORMATION FROM LOW TEMPERATURE SPECIFIC HEAT MEASUREMENTS. Beck, Paul A.; Claus, Helmut (Univ. of Illinois, Urbana). J. Res. Nat. Bur. Stand.; 74A: 449-54(May-Jun 1970).

The calculation of one-electron density of state values from the coefficient γ of the term of the low-temperature specific heat linear in temperature is complicated by many-body effects. In particular, the electron–phonon interaction may enhance the measured γ as much as twofold. The enhancement factor can be evaluated in the case of superconducting metals and alloys. In the presence of magnetic moments, additional complications arise. A magnetic contribution to the measured γ was identified in the case of dilute alloys and also of concentrated alloys where parasitic antiferromagnetism is superimposed on an overall ferromagnetic order. No method has as yet been devised to evaluate this magnetic part of γ. The separation of the temperature-linear term of the specific heat may itself be complicated by the appearance of a specific heat anomaly due to magnetic clusters in superparamagnetic or weakly ferromagnetic alloys. (auth)

40187 INVESTIGATIONS ON THE IONIC CONDUCTIVITY OF SOLID ELECTROLYTES OF Y_2O_3-DOPED ZIRCONIUM OXIDE AND THORIUM OXIDE. Fischer, W. A.; Janke, D. (Max-Planck Institut fuer Eisenforschung, Duesseldorf). Z. Phys. Chem. (Frankfurt); 69: 11-28(Apr 1970). (In German).

Investigations were made on the ionic conductivity of solid electrolytes of the compositions: 92 wt % ZrO_2–8 wt % Y_2O_3, 83 wt % ZrO_2–17 wt % Y_2O_3, and 93 wt % ThO_2–7 wt % Y_2O_3. Measurements were made of emf in the concentration series air/solid electrolyte/H_2O, H_2 and Cr_2O_3, Cr/solid electrolyte/H_2O, H_2 at 700 to 1600°C and oxygen partial pressures of 10^{-21} to 10^{-1} atm. (M.C.G.)

40188 SECOND INTERNATIONAL MEETING ON FERROELECTRICITY, KYOTO, SEPTEMBER 4–9, 1969. Supplement to the Journal of the Physical Society of Japan, Vol. 28, 1970. Tokyo; Physical Society of Japan (1970). 476p. $20.00. (CONF-690955).

The conference papers are listed according to the following categories: (1) theory, (2) nonlinear optics and optical properties, (3) magnetic resonance, (4) dielectric and related properties, (5) phase transition, (6) infrared and Raman spectroscopy, (7) lattice dynamics, (8) critical phenomena, (9) crystal structure, (10) electro-mechanical properties, (11) domain structure and polarization reversal, (12) high pressure and thin films, (13) imperfection, and (14) photo- and semiconducting properties. (M.O.W.)

40189 SENSITIVITY OF POINT DEFECT CHARACTERISTICS TO THE INTERATOMIC POTENTIAL RANGE. DePino, A. Jr. (Pacific Northwest Lab., Richland, Wash.); Doran, D. G.; Beeler, J. R. Jr. Contract AT(45-1)-1830. Radiat. Eff.; 3: 23-31(May 1970).

Point defect characteristics, including configuration and re-

laxation energies of vacancies and interstitials, migration energies of vacancies, and binding energies of divacancies, are determined by computer simulation using models representing copper and α-iron. The sensitivity of these characteristics to small variations in the range of the interatomic potential is studied using potentials of the Morse type modified to include third or fourth neighbors. Vacancy relaxation energies were found to increase and migration energies decrease with increased range. Divacancy binding energies were generally insensitive to range, but were appreciably higher than found with first and second neighbor potentials. The energies of interstitial configurations varied markedly with range, but retained their relative order with one minor exception. The lowest energy configurations for α-iron, however, were the crowdions, rather than the (110) split configuration found in previous work using shallower second neighbor potentials. The significance of arbitrary potential cutoffs and small discontinuities is discussed. (auth)

40190 TEMPERATURE DEPENDENCE OF THERMOMAGNETIC EFFECTS IN BINARY ALLOYS OF Ni WITH Cr, Mo, AND W. Ali-Zade, Z. I.; Kerimov, A. A. (Azerbaydzhan Polytechnic Inst., Baku). Fiz. Metal. Metalloved.; 29: 1114-6(May 1970). (In Russian).

Experimental studies were made of the thermomagnetic effect in Ni alloys with Cr, Mo, and W. An empirical formula was constructed for the concentration-temperature dependence of the thermomagnetic effect in binary alloys with cubic lattices. (R.V.J.)

40191 DEUTERIUM ATOM DISTRIBUTION IN Nb-D SOLID SOLUTIONS. Fender, B. E. F.; Henfrey, A. W. (Oxford Univ.). J. Chem. Phys.; 52: 3250-3(15 Mar 1970).

The diffuse scattering of long-wavelength neutrons (7.0 Å) by niobium-deuterium solid solutions of composition $NbD_{0.042}$ and $NbD_{0.079}$ has been studied. The results indicate that within experimental error the hydrogen atoms are randomly distributed. An incoherent cross section of $2.78 \times 10^{-2} \pm 0.25 \times 10^{-2}$ b is reported for niobium. (auth)

40192 AUGER ELECTRON STUDIES OF UO_2 SURFACES. Campbell, B. D.; Ellis, W. P. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys.; 52: 3303-4(15 Mar 1970).

The LEED unit was modified for energy distribution analysis of the secondary electrons. The (110) and (111) planar surfaces of single-crystal UO_2 were examined. The Auger spectra (dN(E)/dE vs E) were examined for fresh surfaces after heating and after O_2 adsorption. It is concluded that fractional-order beams are produced by an ordered UO_{2+x}(110) surface, that excess O stabilizes the (110) surface through the formation of variable U-O superlattices, and that for stoichiometric oxide, the (110) surface is unstable to facetting at >600°C. (D.L.C.)

Moessbauer Effects and NMR

40193 (IS-T-369) NUCLEAR MAGNETIC RESONANCE HYPERFINE FIELDS IN THE HEXAGONAL LAVES PHASE COMPOUNDS $ScMn_2$, $ErMn_2$, AND $TmMn_2$. Lunde, Barbara Kegerreis (Ames Lab., Iowa). May 1970. Contract W-7405-eng-82. 58p. Dep. CFSTI.

Thesis.

The effect of magnetic rare earth ions on the hyperfine fields in intermetallic compounds with manganese was investigated by comparing the measured hyperfine fields in the asymmetric hexagonal Laves phase compounds $ErMn_2$ and $TmMn_2$ with the hyperfine fields in $ScMn_2$, which is very similar, but does not have the incomplete 4f shell of the rare earths. The fields were measured from 4°K to room temperature. The spectra were very interesting because there are two inequivalent sites for Mn, one of which is completely asymmetric, and the compounds are very well ordered. In the $ScMn_2$ spectrum alone, there were 21 detectable lines. The manganese nuclei are electronically isolated from the rare earth ions. The hyperfine fields at the manganese nuclei remain constant with variation in temperature in all three compounds investigated, even though the magnetic ions become more aligned with the magnetic field at lower temperature, as predicted by the Curie law and verified by measurement of the magnetic susceptibility. There is apparently negligible interaction between the 4f electrons of the rare earth ions and the electrons determining the magnetic environment of the manganese nuclei. This integration was done to compare the width of these two types of lines. The full width of half maximum of the derivative spectrum of a broadened step function is 1.17 times the distance between the extrema of the derivative of a similarly broadened spike. Of course, the maximum derivative of the broadened step function is at the position of the step, so the measured position of the flat shoulder is unaffected by the broadening. If the original function is not a step, but rather the product of a step and a line, with a slope of 0.1 A/t where A is the amplitude of the step and t is a parameter of the Gaussian broadening function, $g(t) = 1/\sqrt{2\pi}\ e^{-t^2/2}$, then the full width at half maximum is 1.3 times the distance between the extrema of the derivative of a similarly broadened spike. The maximum derivative is moved toward the non-zero side of the step by 0.1 t. (auth)

40194 MOESSBAUER EFFECT STUDIES ON ^{151}Eu IN MIXED OXIDE STRUCTURES. Dulaney, G. W.; Clifford, A. F. (Virginia Polytechnic Inst., Blacksburg). pp 65-76 of Moessbauer Effect Methodology. Vol. 5. /Gruverman, Irwin J. (ed.). New York; Plenum Press (1970).

From 5th Symposium on Moessbauer Effect Methodology, New York. See CONF-690221.

In an effort to obtain more nearly monochromatic ^{151}Sm sources for ^{151}Eu a study of the effect of crystal structure on absorption linewidth was undertaken. The broadest lines were found for ternary oxides of presumed high crystal symmetry, such as $EuCrO_3$, while the narrowest lines were found for the soft, asymmetric anhydrous $EuCl_3$. In the case of $Eu_2Ti_2O_7$ quadrupole splitting was observed corresponding to 1.30 ± 0.04 for the ratio of the quadrupole moments of the excited and ground states and with a value of 1.00 ± 0.02 mm/sec for Γ. The measured quadrupole coupling constant was -280 ± 7 Mc/sec. Absorption efficiencies were found, as expected, to be greatest for the most rigid crystals and least for the soft ones. Isomer shifts were found to vary in order of intuitive "ionicity," but in some cases the correlation was much better with mass than with electronegativity. (auth)

40195 POLARIZATION EFFECTS IN MOESSBAUER ABSORPTION BY SINGLE CRYSTALS. Housley, R. M. (North American Rockwell Corp., Thousand Oaks, Calif.). pp 109-21 of Moessbauer Effect Methodology. Vol. 5. /Gruverman, Irwin J. (ed.). New York; Plenum Press (1970).

From 5th Symposium on Moessbauer Effect Methodology, New York. See CONF-690221.

There are a number of reasons for analyzing Moessbauer intensity measurements in single-crystal samples. By studying the total intensity as a function of direction in the crystal, one can hope to obtain the six parameters that describe the mean square displacement at a resonant site. By studying relative intensities in a nonmagnetic crystal, one can hope to obtain the three or four parameters describing the electric field gradient at a resonant site that are not determined by the line positions. In a magnetic crystal one can hope to find the internal field directions and hence to learn a great deal about the magnetic structure. It is necessary to obtain the internal field parameters and mean square displacement values from the measured intensities. This is greatly simplified in several cases that are described. The most important case is if measurements are made along certain high-symmetry directions in otherwise arbitrarily complicated crystals. In these cases the incident gamma-ray beam may be decomposed into two components, each propagating through the crystal with its own complex index of refraction. The deviation of the index of refraction from one may be regarded as due to the part of the incident radiation coherently scattered in the forward direction. Conditions for neglecting effects of coherent scattering in other directions are described. Use of this analysis is illustrated with several examples. These include determination of the mean square displacement tensor for Fe in siderite, determination of the mean square displacement, and refinement of the electric field gradient for Fe in sodium nitroprusside, and explanation of some apparent anomalies which have appeared in the literature. (auth)

40196 DETERMINATION OF ZERO-POINT PHONON PARAMETERS: CALIBRATION OF THE SECOND-ORDER DOPPLER SHIFT. Kitchens, T. A. (Brookhaven National Lab., Upton, N. Y); Craig, P. P.; Taylor, R. D. pp 123-39 of Moessbauer Effect Methodology. Vol. 5. /Gruverman, Irwin J. (ed.). New York; Plenum Press (1970).

From 5th Symposium on Moessbauer Effect Methodology, New York. See CONF-690221.

A considerable body of research has been devoted to the determination of the Moessbauer recoil-free fraction, or f-factor, from which the mean square atomic displacement of resonant nuclei can be deduced. A quantity intimately related to the mean square displacement, but considerably less accessible to experiment, is the mean square velocity. Normally this quantity is hidden amid a wealth of complexity relating to the chemical shifts of source and absorber. A technique was developed for intercomparing two quantities, both directly determined from the Moessbauer experiments — the recoil-free fraction and the second-order Doppler shift — so as to permit deduction of the absolute zero-point mean-square velocity. Results are presented for a number of systems involving both the ^{57}Fe and the ^{119}Sn resonances. (auth)

40197 MOESSBAUER EFFECT IN MICROCRYSTALS. Schroeer, D. (Univ. of North Carolina, Chapel Hill). pp 141-62 of Moessbauer Effect Methodology. Vol. 5. /Gruverman, Irwin J. (ed.). New York; Plenum Press (1970).

From 5th Symposium on Moessbauer Effect Methodology, New York. See CONF-690221.

Major modifications of the crystal lattice occur in microcrystals. An examination was made of the effects of these lattice modifications on various aspects of Moessbauer spectra, together with a summary of the relevant literature. Examples discussed include the following: Surface vibrational modes and partial decoupling from the supporting medium can modify the Debye–Waller factor. The Debye temperature is affected by the "internal pressures" (which can be as much as ±200 kbar) corresponding to the changes in the lattice spacing created by surface effects. These internal pressures can result in isomer shifts. Various chemical valence states may be preferentially stabilized in microcrystals. The finite crystallite size leads to superparamagnetism. Transition temperatures, such as those of the Néel and Morin transitions, may be shifted through the internal pressures. Surface and core distortions through unsaturated chemical bonds and internal pressures can lead to changes in the electric-quadrupole interaction. (auth)

40198 MOESSBAUER EFFECT IN RADIOACTIVE MATERIALS. Boyle, A. J. F.; Perlow, G. J. (Argonne National Lab., Ill.). pp 183-95 of Moessbauer Effect Methodology. Vol. 5. /Gruverman, Irwin J. (ed.). New York; Plenum Press (1970).

From 5th Symposium on Moessbauer Effect Methodology, New York. See CONF-690221.

The general considerations that apply to using unstable isotopes as the absorbing nuclei for the Moessbauer effect are discussed. Preliminary results of various workers with the isotopes 2.6-year ^{147}Pm, 7.2-year ^{133}Ba, 87-year ^{151}Sm, and 47-hr ^{153}Sm are discussed as examples of the techniques involved. (auth)

40199 MOESSBAUER EFFECT: A NEW METHOD FOR MEASURING DIFFUSION. Mullen, J. G.; Knauer, R. C. (Purdue Univ., Lafayette, Ind.). pp 197-208 of Moessbauer Effect Methodology. Vol. 5. /Gruverman, Irwin J. (ed.). New York; Plenum Press (1970).

From 5th Symposium on Moessbauer Effect Methodology, New York. See CONF-690221.

Atomic diffusion in solids was observed by the broadening of the Moessbauer line. There appears to be some advantage to the technique over the more common tracer-sectioning technique for measuring diffusion. In addition to the fact that the technique does not require the destruction of the sample, thereby permitting the measurement of the temperature dependence of the diffusivity with a single specimen, it may afford more accurate results for very rapidly diffusing ions. It also may give a direct handle on the Bardeen–Herring correlation factor, particularly in the cases where the diffusing ion undergoes a very highly correlated motion through the lattice, as is expected for vacancy diffusion of impurities, where the binding energy between the impurity and the vacancy is very large. The data indicate that the temperature dependence of the broadening of the Moessbauer line follows an Arrhenius relation, with a slope parallel to the classical diffusivity for cases that are not highly correlated. In the cases so far studied the broadening is only half of the earlier theoretically predicted value, and the significance of this point is discussed. A novel furnace assembly used for hot-source and hot-absorber experiments under 1100°C is given. (auth)

40200 MOESSBAUER EXPERIMENTS WITH A ^{3}He/^{4}He DILUTION REFRIGERATOR. Kalvius, G. M. (Technical Univ., Helsinki. Argonne National Lab., Ill.); Katila, T. E.; Lounasmaa, O. V. pp 231-67 of Moessbauer Effect Methodology. Vol. 5. /Gruverman, Irwin J. (ed.). New York; Plenum Press (1970).

From 5th Symposium on Moessbauer Effect Methodology, New York. See CONF-690221.

The large cooling capacity of ^{3}He/^{4}He dilution refrigerators has made the temperature region below some hundredths of a degree available for Moessbauer resonance experiments. A spectrometer that allows the cooling of either the source or the absorber or both is described. Temperatures as low as 0.03°K were reached with this system. The application of very low temperatures is of interest for certain solid-state properties, such as low-lying magnetic transitions, paramagnetic relaxation, and localized magnetic moments, including the Kondo effect. It further allows Moessbauer measurements on oriented nuclei, which leads to an absolute thermometer, and gives information concerning the hyperfine interaction at the parent nuclei and the β-decay matrix elements. In addition to a general discussion of these applications, data obtained with the Moessbauer isotopes ^{57}Fe, ^{151}Eu, and ^{197}Au are presented. (auth)

40201 SCHEME FOR SENSITIVE NUCLEAR DOUBLE-RESONANCE DETECTION: DEUTERIUM AND ^{13}C. Schwab, M.; Hahn, E. L. (Univ. of California, Berkeley). J. Chem. Phys.; 52: 3152-67(15 Mar 1970).

An experiment which involves the participation of three nuclear spin species is carried out to accomplish sensitive double-resonance detection of nuclei. An ordered nuclear quadrupole spin system (A) is used to establish and monitor a metastable ordered state of a second abundant spin system (B). A double-resonance coupling is brought about between the B spin system and a third rare or weakly interacting system (C) to accomplish the detection of the C resonance. The usefulness of this scheme lies in the choice of an A system with a short spin–lattice relaxation time (T_{1A}) and a B system with a long spin–lattice relaxation time (T_{1B}). The choice of a long T_{1B} increases the sensitivity of the experiment in that a long time is available during which effective nuclear dipole–dipole cross relaxation can occur between the B and C systems. With a short T_{1A}, the cycling rate at which information is gathered to detect the C system is enhanced by a factor $\sim T_{1B}/T_{1A}$ over that of the earlier two species double-resonance method. For increased sensitivity T_{1B} can be chosen arbitrarily long, while for the purposes of an increased rate of data acquisition, T_{1A} can be chosen arbitrarily short, thus producing an efficient double-resonance scheme. This scheme is applied to a 12% deuterium enriched sample of paradichlorobenzene. The nuclear quadrupole-coupled ^{35}Cl reservoir acts as the A system. The zero-field nuclear quadrupole resonance system (at 34.78 mHz at 77°K) supplants the usual high-field stabilized magnet and power supply required in an NMR double-resonance experiment. The B proton system has a zero field lifetime of 46 sec, and approximately a 1-hr lifetime at 135 G. The C systems investigated are (1) deuterium and (2) the naturally abundant ^{13}C nuclei in paradichlorobenzene. An analysis of double-resonance detection of I = 1 spin systems is given and shows that for a well-resolved nuclear quadrupole asymmetry η splitting, a double resonance cannot be detected because of the nonsecular character or quenching of cross-relaxation interaction terms. The analysis is extended to include the unquenching effect of constant magnetic fields and the integer I > 1 quadrupole system is discussed. The observation of the ^{13}C resonance is the first reported observation through the nuclear magnetic resonance techniques of the 1.1% naturally abundant ^{13}C in a solid. (auth)

40202 NUCLEAR RELAXATIONS IN DYNAMIC ORIENTATION OF NUCLEI. Sukheeja, B. D. (Regional Engineering Coll., Kurukshetra, India); Narchal, M. L. J. Appl. Phys.; 41: 3905-6(Aug 1970).

It was pointed out earlier by Jeffries that, in some cases, direct nuclear spin–lattice relaxations may be as important as other mechanisms in establishing equilibrium populations among the nuclear sublevels of a suitably pumped electron–nuclear-coupled spin system subjected to a static magnetic field; however, this effect has been neglected in the calculations of dynamic nuclear polarization reported so far. In this note the nuclear relaxations are included (although not very rigorously because of difficulties regarding some insummable finite series encountered) to make it more realistic for samples in which these relaxations may be quite appreciable because of strong nuclear quadrupole interactions or some other mechanisms. The calculational results are shown here for the Pa^{4+} ion in Cs_2ZrCl_6, experimental results for which have already been published (Phys. Rev., 121: 1630 (1961)). A comparison of the results with earlier calculations shows that the general features of polarization curves remain unaltered by introduction of spin–lattice relaxations when Δ (the electron Zeeman splitting) is >0.1, except that the effect of incomplete saturation is still less important than in the absence of these relaxations. (L.M.T.)

Theoretical Physics

Refer also to abstracts 39915, 39986, 40159, and 40433.

40203 CONTRIBUTION OF THE COHERENT QUASIBOSON-APPROXIMATION MODES TO GROUND-STATE CORRELATIONS. da Providencia, J. (Univ., Coimbra, Portugal. Instituto de Alta Cultura, Lisbon). Phys. Rev., C; 1: 411-13(Feb 1970).

It is well known that the random-phase approximation (RPA) overestimates correlation effects. This shows that the RPA assumptions are at least partially violated, and constitutes a serious difficulty. In order to understand the origin of this difficulty, a calculation of the correlation energy of the electron gas was performed by a version of the RPA dealing only with collective excitations. As expected, it was found that the modified RPA is free of the error of the conventional RPA, showing that this error is connected with the noncollective RPA modes. (auth)

40204 DIRAC ELECTRON IN PARALLEL ELECTRIC AND MAGNETIC FIELDS. Lam, L. (Columbia Univ., New York). Phys. Lett.; 31A: 406(6 Apr 1970).

Exact solutions of a Dirac electron in constant parallel electric and magnetic fields are found and given explicitly. The case of the Klein–Gordon equation is shown to be a special case. (auth)

40205 HOW GOOD IS THE HARTREE–FOCK APPROXIMATION. II. THE CASE OF CLOSED SHELLS. Calles, A.; Moshinsky, M. (Univ., Mexico, Mexico City). Amer. J. Phys.; 38: 456–67(Apr 1970).

The problem of an arbitrary number of particles A in a harmonic-oscillator force is analyzed. The particles have spin ½ and obey Fermi statistics. The exact lowest eigenstate and energy are derived for values of A corresponding to closed subshells. An approximate analysis is also made using determined wave functions formed from single-particle harmonic-oscillator states, giving the eigenstates and energies of a simple form of the Hartree–Fock approximation. The exact and Hartree–Fock energies and eigenstates are compared both when potential and force have the same sign, and when they have opposite signs. The results for models which are called pseudonuclei and pseudoatoms are discussed, and some of the inferences for the real thing are discussed. (auth)

40206 DYNAMICAL EQUATIONS FOR SPINLESS, NEUTRAL BOSON SYSTEM. PART II. OFF THE MASS-SHELL FORMULATION. Garczynski, W. (Univ. of Wroclaw). Acta Phys. Pol.; A37: 699–708(May 1970).

Functional description of an infinite system of spinless, neutral particles is given in terms of quantities extrapolated of the mass-shell. Quantum Markovian property is postulated and corresponding differential dynamical equations are derived. Finally, the connection with the Rzewuski functional formulation of the quantum field theory is established. (auth)

40207 DYNAMICAL EQUATIONS FOR SPINLESS, NEUTRAL BOSON SYSTEM. PART I. ON THE MASS-SHELL FORMULATION. Garczynski, W. (Univ. of Wroclaw). Acta Phys. Pol.; A37: 689–97(May 1970).

The S-matrix theory is proposed in terms of observable quantities, i.e., in terms of matrix elements lying on the mass-shell only. A quantum Markovian process is constructed for an infinite system of spinless neutral particles and the corresponding dynamical equations are derived with the use of functionals technique. (auth)

40208 STUDY OF THE DE BROGLIE MOMENTUM ENERGY TENSOR AND OF THE SPIN DENSITY IN THE VANISHING WAVE. Ricard, Jean. Compt. Rend., Ser. B; 270: 661–4(9 Mar 1970). (In French).

The de Broglie dissymmetrical tensor in the vanishing wave is calculated when the second medium is vacuum. The momentum of a photon is in agreement with the value of $h\bar{k}$. The variation of the apparent velocity of the energy, and of the spin density with the incident wave polarization, is studied. (tr-auth) (France)

40209 CHERENKOV RADIATION BY A PARTICLE WITH ALTERNATING SPIN ½ TO ³⁄₂. Lobko, S. I. (Belorussian State Univ., Minsk). Dokl. Akad. Nauk BSSR; 14: 115–18 (Feb 1970). (In Russian).

Cherenkov radiation intensity of particles with variable spin ½ to ³⁄₂ and two rest mass states were evaluated without taking into account particle polarization or photon emission. Calculations were carried out by means of mass and spin projection operators constructed for the particle. The radiation intensity increased with the increase of particle pulses proportional to the sixth power of the ³⁄₂-spin particle and to the 4th power with the spin-½ particle. The electron radiation intensity is proportional to the square of the pulse. A much more complex evaluation was demanded for evaluating the intensity of radiation as a function of the angle of radiation. The radiation intensity of particles with a 2e mass and ³⁄₂ spin was compared to the particle with the spin ³⁄₂ and a single mass state. (R.V.J.)

40210 DIAGONALIZATION OF HAMILTONIAN OPERATORS IN FIELD THEORY FORMULATION OF NONRELATIVISTIC MULTICHANNEL SCATTERING. Walter, R. (Univ., Stuttgart). Z. Naturforsch.; 25a: 329–35(Mar 1970). (In German).

The general procedure of diagonalizing a field-theoretical Hamiltonian in the special case of a multichannel scattering problem in which the asymptotic fields and the interpolating field are connected by a nonunitary transformation is discussed. (auth)

40211 RADIATION OF ARBITRARY MOVING CHARGES IN DISPERSING MEDIA WITH A SPHERICAL INTERFACE. Magomedov, M. R. (Erevan Inst. of Physics). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 4: 271–81(1969). (In Russian).

A solution of Maxwell equations for the case of two dispersing media with a spherical interface by the Green's function method is obtained for arbitrarily distributed external sources. The asymptotic expressions for the fields are also given. By the solution obtained one may consider numerous problems, from diffraction of an arbitrarily given pulse on a sphere to electrostatic problems. The intensity of the radiation for the charge uniformly rotating around the dielectric sphere is also calculated. (auth)

40212 RADIATION AND ENERGY LOSSES OF A CHARGED PARTICLE TRAVERSING A LAYERED MEDIUM. Arakelyan, V. A.; Garibyan, G. M.; Nalyan, E. A. (Inst. of Radio Physics and Electronics, Erevan. Erevan Inst. of Physics.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 4: 287–97(1969). (In Russian).

The passage of a charged particle through an arbitrary number of material layers separated by vacuum spaces is considered. Expressions are derived for fields of radiation generated both inside and outside a stack of plates. With the help of these formulas the expression for total energy losses of a charge in a stack of plates is also derived. (auth)

40213 ACCELERATION AND TRAPPING OF PARTICLES BY RADIATION PRESSURE. Ashkin, A. (Bell Telephone Labs., Holmdel, N. J.). Phys. Rev. Lett.; 24: 156–9(26 Jan 1970).

Micron-sized particles have been accelerated and trapped in stable optical potential wells using only the force of radiation pressure from a continuous laser. It is hypothesized that similar accelerations and trapping are possible with atoms and molecules using laser light tuned to specific optical transitions. The implications for isotope separation and other applications of physical interest are discussed. (auth)

40214 SOLUTION FOR A PROBLEM ON RADIATION GENERATION BY A MOVING CHARGE IN A PLATE AND IN A STACK OF PLATES BY THE METHOD OF DERIVATION FROM FAMILIAR AND MORE ELEMENTARY FIELDS. Arakelyan, V. A.; Garibyan, G. M. (Inst. of Radio Physics and Electronics, Erevan. Erevan Inst. of Physics). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 4: 339–51(1969). (In Russian).

The formulas, previously derived for radiation produced by a charge in a plate and a stack of plates, are transformed in a new form. These formulas are shown to have a clear physical meaning since they can be derived from more elementary expressions. In the case of a plate, they can be derived from the solutions of a problem for one interface of media, taking into account laws of radiation propagation in a plate; in the case of a stack of plates, it is sufficient to know the solution of a problem for one plate and to take into account the laws of radiation propagation in a laminated medium. (auth)

40215 COLLISION INTEGRAL OF A FERMI GAS IN WHICH COULOMB INTERACTION IS TAKING PLACE. Draganu, Mircea Compt. Rend., Ser. B; 270: 1369–71(1 Jun 1970). (In French).

An expression is deduced for the collision integral of a Fermi gas, which is analogous to that established by Landau for a classical gas. (tr-auth) (France)

40216 DOUBLE DISPERSION RELATIONS IN QUANTUM STATISTICAL MECHANICS. II. Rajagopal, A. K. (Tata Inst. of Fundamental Research, Bombay); Cohen, Morrel H. Proc. Indian Acad. Sci., Sect. A; 71: 149–66(Apr 1970).

Double dispersion relations are given for the functions $\gamma(12;3) = 1/i\langle T(\psi(1)\psi^{\dagger}(2)B(3))\rangle$, common in many electron problems. Here ψ and $\psi^{\dagger}$ refer to electron destruction and creation operators, and B(3) is a boson or boson-like operator such as particle density, ion displacement, local spin, particle current density, or electron spin density. Consequences of Hermiticity properties and time-reversal invariance, as well as sum rules, are established for the spectral density functions entering the double dispersion relations. A subtracted double dispersion relation is suggested for the corresponding vertex function. Details of the derivation and examples are given that were not included in an earlier brief report of this work. (auth)

40217 QUANTUM MECHANICS WITH APPLICATIONS. Beard, David B.; Beard, George B. Boston; Allyn and Bacon, Inc. (1970). 342p. $11.95.

The following chapters are included: (1) black-body radiation, (2) Fourier analysis, (3) diffraction and interference of photons and particles, (4) Feynman path integrals and the Schroedinger equation, (5) use of the wave function to obtain physical properties of a system, (6) one-dimensional problems, (7) the WKB approximation and the Bohr–Sommerfeld quantum conditions, (8) elementary three-dimensional wave functions in spherical coordinates, (9) perturbation theory, (10) time-dependent perturbation theory, (11) the one-electron atom (12) multi-electron

atoms, (13) molecular structure, (14) free electron and band theory of metals, (15) elastic scattering theory, and (16) nuclear forces and models. (M.O.W.)

40218 LECTURES ON ELECTRODYNAMICS. Oppenheimer, J. Robert. Documents on Modern Physics. New York; Gordon and Breach, Science Publishers, Inc. (1970). 172p. $14.50.

Maxwell's theory of classical electrodynamics is described in detail. A detailed description of the special theory of relativity is also given. (M.O.W.)

40219 EFFECT OF STEADY MAGNETIC FIELD ON CHARGED PARTICLE MOTION IN DILUTED SOLUTIONS. Evdokimov, V. B. Vestn. Mosk. Univ., Ser. II. Khim.; 11: 174-83(Mar-Apr 1970). (In Russian).

It is shown that Brownian motion of charged particles under the action of a magnetic field can be described by a combination of harmonic oscillator equations. The relation between motion equations in the xy plane ($H_x = H_y = 0$; $H_z = H$) is given by a linear combination of random functions. Diffusion coefficient anisotropy is shown to be a result of the action of the magnetic field. (auth)

40220 QUANTUM MARKOVIAN PROCESSES IN EUCLIDEAN SPACE AND THE ELECTROMAGNETIC STRUCTURE OF THE SCHROEDINGER EQUATIONS. Garczynski, W. (Wroclaw Univ.). Acta Phys. Pol.; A38: 61-70(1970).

Quantum Markovian processes, introduced earlier by the author, in three-dimensional Euclidean space are discussed. They correspond to the simplest possible quantum systems, i.e., to spinless particles moving under the influence of an external electromagnetic field and other possible forces. The most general Schroedinger equations are derived and discussed. In particular, the dependence of the coefficients of these equations on electromagnetic potentials is investigated without any reference to the analogy with the classical mechanics case. (auth)

40221 COLLAPSE ONTO SCATTERING CENTER IN QUANTUM MECHANICS. Perelomov, A. M.; Popov, V. S. Teor. Mat. Fiz.; 4: 48-65(Jul 1970). (In Russian).

The collapse onto scattering center is investigated for attractive potentials singular in $r \to 0$. In this case physical quantities, such as energy levels, scattering length, S-matrix etc., are not determined uniquely by the Hamiltonian H. To make the problem mathematically correct, it is necessary to introduce an additional constant γ. From the viewpoint of its physical meaning, γ represents the value of the scattering phase at $r = 0$ and takes phenomenologically the account of the potential cut-off at small distances. From the mathematical viewpoint, γ determines the choice of the self-adjoint extension of the formally hermitian operator H. A number of concrete potentials is considered which allow the solution of the Schrödinger equation in the analytic form, and the dependence of physical quantities upon γ is demonstrated by these examples. A discussion is given of the collapse phenomenon in the one-dimensional N-body problem. (auth)

40222 STIMULATED SYNCHROTRON RADIATION OF ELECTRONS IN A PIECEWISE-HOMOGENEOUS MAGNETIC FIELD. Kuraev, A. A.; Stepukhovich, V. A.; Zhurakhovskii, V. A. JETP Lett. (USSR) (Engl. Transl.); 11: 289-90(5 May 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 429-31(5 May 1970).

Grigorév et al. have investigated stimulated synchronous emission of electrons in a hollow system imbedded in a homogeneous magnetic field. In this paper the case of an inhomogeneous field is considered. The feasibility of almost complete conversion of the energy of rotational motion of the electrons into radiation energy is demonstrated theoretically. (L.M.T.)

40223 RESOLUTION OF A THEORETICAL ENERGY PARADOX IN CLASSICAL ELECTRON THEORY. Leiter, D. J. (Boston Coll.). Lett. Nuovo Cim.; 3: 101-4(22 Jan 1970).

Cloetens, Castillo, et al. [Nuovo Cimento, 62A, 247(1969)] have shown what apparently is a theoretical energy paradox in the description of classical point electron moving in an external, uniform magnetic field. An attempt is made to study this result in the light of the associated electromagnetic conservation laws and to show that actually there is no paradox involved and that there is nothing wrong with the Dirac–Plass solution of the Lorentz–Dirac equation for this case. (M.H.R.)

40224 BREMSSTRAHLUNG IN CRYSTALS. Ferretti, B. (CERN, Geneva); Gamberini, G. Lett. Nuovo Cim.; 3: 113-16 (22 Jan 1970).

In studying bremsstrahlung in crystals previously, the Born approximation was used but it was also predicted that because of unitarity, at very high energy the Born approximation would break down completely. The point is discussed here, beginning by investigating the effect of a more correct treatment of motion of the electron (or positron) in the crystal, on the probability of emission of radiation. The interaction with the radiation filed, even here, is being treated in the Born approximation. To get a sufficiently good wave function for the electron in the crystal, a version of the WKB method was developed, which appears to be increasingly suitable with increasing energy of the particle. It may be shown then that for electrons, whose average momentum makes a very small angle with some of the principal crystal planes II, the wave function can be approximately derived by averaging the effects of the potential due to all the atoms belonging to the same crystal's plane parallel to II, and separating therefore the variables. The effect of the crystal potential can then be assimilated to that of a plane structure, and the potential of this structure is represented by a periodic function of one variable only. (M.H.R.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 40290, 40295–40297, and 40509.

Electromagnetic

Refer also to abstracts 39351 and 40395.

40225 (DESY–70/16) PHOTOPRODUCTION OF ρ^0 MESONS ON DEUTERONS BETWEEN 1 AND 5 GeV. AACHEN–BONN–HAMBURG–HEIDELBERG–MUENCHEN COLLABORATION. Hilpert, H. G.; Lauscher, P.; Matziolis, M.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Apr 1970. 49p. Dep. CFSTI (U. S. Sales Only).

The reactions $\gamma d \rightarrow d\pi^+\pi^-$ and $\gamma d \rightarrow pn\pi^+\pi^-$ were investigated in a deuterium bubble chamber. Invariant mass spectra are presented; ρ^0 production is dominant in both reactions. Differential and total cross sections for ρ^0 production were determined. The results are compared with the reaction $\gamma p \rightarrow p\rho^0$ within the framework of the impulse approximation, assuming equal ρ^0 photoproduction amplitudes on the proton and the neutron. (auth)

40226 (DESY–70/17) TOTAL CROSS SECTION FOR PHOTOPRODUCTION OF HADRONS ON HYDROGEN AND DEUTERIUM BETWEEN 1.0 AND 6.4 GeV. Meyer, H.; Naroska, B.; Weber, J. H.; Wong, M.; Heynen, V.; Mandelkow, E.; Notz, D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1970. 19p. Dep. CFSTI (U. S. Sales Only).

The total cross section for hadron production by photons on hydrogen $\sigma(\gamma p)$ and deuterium $\sigma(\gamma d)$ was measured. The experiment used a tagged photon beam with energies from 1.0 to 6.4 GeV and counters surrounding a liquid $H_2(D_2)$-target. The cross section on neutrons is determined from the D_2 and H_2 data using a Glauber correction. (auth)

40227 (IFA-CR–60) A METHOD FOR SIMULTANEOUS DETECTION OF DALITZ PAIRS AND LOCALIZATION OF π^0-ORIGINS (THE GLOBAL FIT PROCEDURE). Friedlaender, E. M.; Marin, A. G. (Institutul de Fizica Atomica, Bucharest (Romania)). 1970. 16p. Dep. CFSTI (U. S. Sales Only).

The detection of π^0 mesons produced in interactions of high energy particles with emulsion nuclei and decaying via the Dalitz mode is reduced to the testing of the zero hypothesis that all the measured tracks emerging from the star originate at a common point. A global fit procedure is applied simultaneously to all grains of the measured tracks; an area around the assumed star origin is scanned, looking for a point where the χ^2 of the whole star reaches a minimum. Significantly large χ^2_{min} values are interpreted as evidence for the presence of a Dalitz pair. Electron tracks are found by successive elimination. Results of a Monte Carlo calculation are presented which yield for the first time the r.m.s. radius of the circle of confusion around the star origin, as well as confidence levels for the detection of Dalitz pairs. (auth)

40228 (LAL–1236) BACKWARD PHOTOPRODUCTION OF K^+ MESONS FROM HYDROGEN BETWEEN 1 AND 2 GeV. Decamp, D.; Dudelzak, B.; Eschstruth, P.; Fourneron, Th. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Jul 1970. 20p. (CONF-700806–17). Dep. CFSTI (U. S. Sales Only).

From 15th International Conference on High Energy Physics, Kiev, USSR.

At the Orsay Linear Accelerator the photoproduction of $K^+\Lambda$ and $K^+\Sigma_0$ from hydrogen at photon energies between 1 and 2 GeV, mainly at fixed backward CM angles of emission of the K^+ meson was investigated. After momentum selection by a magnetic spectrometer the K^+ mesons were identified by time of flight, specific ionisation measurements and use of a Čerenkov counter. Structures are apparent in the backward photoproduction cross sections at total CM energies around 1700 MeV and around 1900 MeV, rather close to some of the known resonances. (auth)

40229 (LNF–70/37) MULTIPLE PARTICLE PRODUCTION FROM e^+e^- INTERACTIONS AT C. M. ENERGIES BETWEEN 1.6 AND 2 GeV. Note No. 488. Bartoli, B.; Coluzzi, B.; Felicetti, F.; Goggi, G.; Marini, G.; Massa, F.; Scannicchio, D.; Silvestrini, V.; Vanoli, F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 24 Jul 1970. 20p. (CONF-700806–22). Dep. CFSTI (U. S. Sales Only).

From 15th International Conference on High Energy Physics, Kiev, USSR.

The cross section for multiple particle production in $e^+ + e^-$ interactions at 1.6 and 2 GeV is found to be of the order of $3(10)^{-32}$ cm^2. This cross section was observed by four telescopes with scintillation counters and spark chambers. (J.F.P.)

40230 AN EXPERIMENTAL STUDY OF THE LONGITUDINAL DEVELOPMENT OF ELECTRON INITIATED CASCADES IN LEAD IN THE ENERGY RANGE 0.5 TO 4.0 GeV. Jakeways, R.; Calder, I. R. (Univ. of Leeds, Eng.). Nucl. Instrum. Methods; 84: 79–82 (1970).

The longitudinal development of cascade showers in lead initiated by electrons of known energy from an accelerator beam has been studied. Comparisons are made with other experimental results and with various theoretical calculations. Considerable discrepancies are seen to arise which are discussed. (auth)

40231 PROTON–PROTON BREMSSTRAHLUNG AT 99 MeV. Sannes, F.; Trischuk, J.; Stairs, D. G. (McGill Univ., Montreal). Nucl. Phys.; A146: 438–48(1970).

The reaction $p + p \rightarrow p + p + \gamma$ at 99 MeV was investigated. The two final-state protons were detected in coincidence at equal polar angles on opposite sides of the beam. Cross sections $d\sigma/d\Omega_1 d\Omega_2$ of 3.77, 5.14, 9.01 and 18.8 μb/sr^2 ± 5% were obtained at laboratory angles of 25, 30, 35 and 40° respectively. The angular distributions of the photons were inferred and were found to have shapes which are characteristic of quadrupole radiation. (auth)

40232 EVIDENCE IN SUPPORT OF A SMALL VALUE FOR THE η $\pi^0\gamma\gamma/(\pi^0\gamma\gamma + 3\pi^0)$ BRANCHING RATIO. Kanofsky, A. (Lehigh Univ., Bethlehem, Pa.). Nuovo Cim., 68A: 413–25 (1 Aug 1970).

An analysis of some early η data gives a value of 0.1^{+}_{-} for the $\pi^0\gamma\gamma/(\pi^0\gamma\gamma + 3\pi^0)$ branching ratio. The experiment and data analysis are discussed. (auth)

40233 PHOTOPRODUCTION OF ELECTRON–POSITRON PAIRS AT 2.3 AND 5.6 GeV. Tenenbaum, J.; Eisner, A. M.; Feldman, G. J.; Lockeretz, W.; Pipkin, F. M.; Randolph, J. K. (Harvard Univ., Cambridge, Mass.). Contract AT(30–1)–2752. Phys. Rev., D; 2: 57–77(1 Jul 1970).

The photoproduction of electron-positron pairs from carbon was measured using an improved version of the Harvard pair spectrometer. The bending magnet and two half-quadrupole magnets were retained. For each half-quadrupole, a tungsten collimator was added at the entrance, a portion of the lead obstacle was removed, and a defining counter was added at the midpoint. Faster counting electronics and an on-line computer were employed. Pairs were detected in an invariant-mass range of 97 to 445 MeV. The results are in agreement with the predictions of quantum electrodynamics and may be parametrized as $R = (1.09 \pm 0.07) \times [1 + (31.6^{+}_{-})] \times 10^{-6} Q_M^2]$. Here R is the ratio of experiment to theory, and Q_M^2 is the electron-pair mass squared (GeV^2/c^4). The errors include both statistical and systematic effects. In the course of this work, an accurate approximation was derived for the electron-pair cross section. (auth)

40234 RESTRICTED ENERGY LOSS BY EXTREMELY RELATIVISTIC PARTICLES. McNulty, P. J.; Congel, F. J. (Clarkson Coll. of Tech., Potsdam, N. Y.). Phys. Rev., D; 1: 3041–9(1 Jun 1970).

The restricted energy loss of electrons, positrons, protons, and pions passing through nuclear emulsions was measured by observation of the variation in blob and grain density as a function of $\gamma = 1/(1-\beta^2)^{\frac{1}{2}}$. All measurements were made in small areas (7 cm^2) of two Ilford K-5 emulsion pellicles. A careful examination of the variation of blob density with track depth was made in both pellicles. The results of measurements on the relativistic rise ($5 < \gamma < 36$) as well as on the Fermi plateau ($\gamma > 100$) are in agreement with the predictions of the Sternheimer formula using a mean ionization potential I of 434 eV and a cutoff energy W_0 of 6–10 keV. An upper limit of 1% is placed on radiative corrections of the type predicted by Tsytovitch. Correction for the finite number of developable grains traversed by the primary produced a best fit with $W_0 = 6$ keV, in excellent agreement with the maximum energy of a δ ray that comes to rest within the working volume of blob counting. (auth)

40235 DECAY INTO MUON PAIRS OF PHOTOPRODUCED phi MESONS. Hayes, S.; Imlay, R.; Joseph, P. M.; Keizer, A. S.; Stein, P. C. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 25: 393–6(10 Aug 1970).

The yield of φ mesons photoproduced from carbon and decaying into muon pairs was measured. It is found that the product of the lepton-pair branching ratio for the φ and the t = 0 photoproduction cross section is $(0.66 \pm 0.10) \times 10^{-4}$ mb/GeV^2. This number is compared with existing measurements of the branching ratio and the cross section. (auth)

40236 MEASUREMENT OF THE NUCLEAR CAPTURE RATE OF MUONS BY FREE DEUTERONS. Placci, A. (CERN, Geneva); Zavattini, E.; Bertin, A.; Vitale, A. Phys. Rev. Lett.; 25: 475-8 (17 Aug 1970).

The nuclear capture rate of negative muons by deuterons in μd atoms was measured. The experiment was performed by stopping negative muons in a target of ultrapure gaseous hydrogen at 7.6 atm with 5.2% deuterium and looking at the outgoing neutrons. The result is $\Lambda_{expt} = 451 \pm 70$ sec^{-1}. (auth)

40237 PHOTOPRODUCTION OF RHO MESONS FROM HYDROGEN AND CARBON BY LINEARLY POLARIZED PHOTONS. Diambrini-Palazzi, G.; McClellan, G.; Mistry, N.; Mostek, P.; Ogren, H.; Swartz, J.; Talman, R. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 25: 478-81(17 Aug 1970).

The photoproduction of ρ^0 mesons from hydrogen and carbon was measured at 3.5 GeV using polarized photons from coherent bremsstrahlung produced by 10-GeV electrons on a diamond crystal. Asymmetry ratios for carbon and hydrogen are measured and are consistent with the mainly diffractive nature of ρ^0 photoproduction. A small nondiffractive component is suggested in the case of hydrogen. (auth)

40238 TEST OF T INVARIANCE IN ELECTROMAGNETIC Σ DECAY. Baggett, Millicent J.; Glasser, Robert G.; Kehoe, Brandt (Univ. of Maryland, College Park). Phys. Rev., D; 1: 2985-8(1 Jun 1970).

As a test of time-reversal invariance in electromagnetic interactions, a measurement was made of a T-invariance-forbidden polarization of the Λ^0 in the decay $\Sigma^0 \rightarrow \Lambda^0 + e^+ + e^-$. The result of this experiment, combined with a previous measurement (also using stopping K^- mesons in hydrogen bubble chambers as a source of Σ^0 hyperons), is a polarization of $(3 \pm 6)\%$. (auth)

Weak

Refer also to abstract 39349.

40239 (CALT-68-251) TEST OF THE $\Delta S = \Delta Q$ RULE IN K^0_{l3} DECAY. Sciulli, F. J.; Gallivan, J. D.; Binnie, D. M.; Gomez, R.; Mallary, M. L.; Peck, C. W.; Sherwood, B. A.; Tollestrup, A. V.; van Putten, J. D. (California Inst. of Tech., Pasadena). [1970]. Contract AT(11-1)-68. 30p. (CONF-700806-24). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

The time distribution of the $\pi^+e^-\nu$ and $\pi^-e^+\nu$ modes from initial K^0's in a spark chamber experiment performed at the LRL Bevatron was measured. From 1079 events in the fiducial volume, between 0.2 and 7 K^0_1 lifetimes, it is found that $ReX = -0.069 \pm 0.036$, $ImX = +0.108^{+0.055}_{-0.055}$. This result is within two standard deviations of X = 0, and therefore consistent with it (Relative probability = 0.25). It is, on the other hand, more than four standard deviations from the existing world average (+0.14, −0.13), and therefore inconsistent with this value (Relative probability $< 3.3 \times 10^{-4}$). (auth)

40240 (COO-1195-187) THREE BODY DECAYS OF NEUTRAL K MESONS. Abashian, A.; Graham, M.; Jones, L.; Mantsch, P.; Orr, R.; Smith, J.; Stutzke, R. (Illinois Univ., Urbana. Dept. of Physics); Glaubman, M. J. (Northeastern Univ., Boston, Mass.). Jun 1970. 14p. (CONF-700806-16). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

Decays of neutral K mesons produced through the associated production reaction $\pi^- + p \rightarrow \Lambda^0 + K^0$ were observed in a magnetic spectrometer spark chamber system at the Argonne ZGS. By observing the distribution in time of the K^0 decays into the K_{e3}, $K_{\mu3}$ and $K_{\pi3}$ modes, we have been able to test the $\Delta S = \Delta Q$ rule and to look for CP violation in these decay modes. Preliminary results are consistent with no $\Delta S = \Delta Q$ amplitude and with no amplitude for $K^0_2 \rightarrow \pi^+\pi^-\pi^0$. (auth)

40241 ANOMALOUS SCATTERING OF PENETRATING UNDERGROUND COSMIC-RAY PARTICLES. Cottrell, D. M. (San Diego State Coll., Calif.); Piserchio, R. J.; Lord, J. J. Contract N00014-68-C-0121. Lett. Nuovo Cim.; 4: 124-8(25 Jul 1970).

The inelastic nuclear interactions of muons at high energies were studied in nuclear emulsions underground. The data were analyzed for information concerning the angular distribution and inelastic cross section of the muon–nucleon interaction. The results show an apparent disagreement between the underground cosmic ray experiments and the high-energy muon experiments carried out with accelerators. A large flux of particles with a total cross section about the same as that of the muon but having a much different scattering distribution is required to account for these data and other similar past experiments. (J.F.P.)

40242 MEASUREMENT OF THE VELOCITY DEPENDENCE OF THE HELICITY OF BETA PARTICLES FROM ^{60}Co. Lazarus, D. M.; Greenberg, J. S. (Yale Univ., New Haven). Contract AT(30-1)-2726. Phys. Rev., D; 2: 45-57(1 Jul 1970).

A series of experiments has been carried out to study the velocity dependence of the helicity $\mathcal{H}$ of β particles from the allowed Gamow-Teller decay in ^{60}Co. The energies examined were varied from 205 keV (v/c = 0.7) to 50 keV (v/c = 0.41), a region where the velocity is changing rapidly with energy, and where several other measurements have reported deviations from $\mathcal{H} = -v/c$. No discrepancy was observed with a $-v/c$ dependence for the helicity within a measurement accuracy of a few percent at the highest velocities and 9% at the lowest velocity. The weighted mean of the helicity measurements is $-\mathcal{H}/(v/c) = 1.014 \pm 0.018$. Assuming, in turn, either the two-component neutrino theory with predominantly axial-vector interaction or the absence of any tensor interaction admixture, this result limits the ratio C_T/C_A to <0.0029, and the ratio C_A'/C_A to values between 0.90 and 1.11. The helicity was analyzed by Mott scattering after transformation of the polarization from longitudinal to transverse. A screened Mott scattering function $S(\theta)$ was used in the analysis. The behavior of depolarization effects and the other systematic errors associated with the technique as a function of β-particle energy was investigated extensively, and the influence of these effects on the results is reported. (auth)

40243 MEASUREMENT OF THE PIONIC AND LEPTONIC DECAY ASYMMETRIES OF POLARIZED Σ^- WITH A PEPR SYSTEM. Bogert, D. (Yale Univ., New Haven. Brookhaven National Lab., Upton, N. Y.); Lucas, P.; Taft, H.; Willis, W.; Berley, D.; Yamin, P.; Kofler, R.; Meissner, G.; Yamamoto, S. Phys. Rev., D; 2: 6-29(1 Jul 1970).

The asymmetry parameter α_- for the nonleptonic decay $\Sigma^- \rightarrow n + \pi^-$ as well as the asymmetry parameter α_{lept} for the leptonic decays $\Sigma^- \rightarrow n + e^- + \bar{\nu}_e$ and $\Sigma^- \rightarrow n + \mu^- + \bar{\nu}_\mu$ were measured using polarized Σ^- produced in the reaction $K^- + p \rightarrow \Sigma^- + \pi^+$ in the vicinity of the $\Lambda(1520)$ resonance. Measurements were carried out on the Yale Precision Encoding and Pattern Recognition (PEPR) system, and leptonic decays were subjected to gap-length analysis. Using the Σ^- polarization function of Thompson, $\alpha_- = -0.067 \pm 0.011$ was found based on 60,000 two-body decays; $\alpha_{lept} = +0.23 \pm 0.44$ based on 44 electron decays; $\alpha_{lept} = +0.36 \pm 0.39$ based on 44 electron decays and 19 muon decays. The value of α_{lept} yields a ratio of axial-vector to vector matrix elements given by $g_A/g_V = -0.33^{+0.11}_{-0.08}$, using a sign convention in which this ratio is negative for the neutron. While the data favor a negative sign for this ratio (in disagreement with the Cabibbo theory), a positive sign cannot be excluded. (auth)

40244 EXPERIMENTAL STUDY OF THE $K^0_{\mu3}$ FORM FACTORS. Basile, P.; Cronin, J. W.; Thevent, B.; Turlay, R.; Zylberajch, S.; Zylbersztejn, A. (CEN, Saclay, France). Phys. Rev., D; 2: 70-90(1 Jul 1970).

A spark-chamber experiment is described which measured the distribution in the Dalitz plot of 3140 $K^0_{\mu3}$ decays, and measured the branching ratio $\Gamma(K_L \rightarrow \pi\mu\nu)/\Gamma(K_L \rightarrow \pi e\nu)$. From a study of the Dalitz plot, a ratio of form factors $\xi = -3.9 \pm 0.4$ is found with little or no energy dependence. The branching-ratio measurement gives a value $\xi = -0.5 \pm 0.5$ which is incompatible with the Dalitz-plot result. The results are discussed from the point of view of possible experimental bias. The results are compared with other experiments. (auth)

40245 STUDY OF THE $\Delta S = \Delta Q$ RULE IN THE LEPTONIC DECAYS OF THE NEUTRAL K MESON. Cho, Y. (Carnegie-Mellon Univ., Pittsburgh); Dralle, A.; Canter, J.; (and others). Phys. Rev., D; 1: 3031-9(1 Jun 1970).

The validity of the $\Delta S = \Delta Q$ rule was tested by studying the time distributions of leptonic decays of neutral K mesons produced in the reaction $K^+d \rightarrow K^0pp$. On the basis of 215 events with known leptonic charge, for x, the ratio of the violating to nonviolating amplitude, $Rex = 0.12 \pm 0.09$ and $Imx = -0.08 \pm 0.07$, is found. The result is consistent with no violation. (auth)

40246 LIMIT ON THE $K^+ \rightarrow \pi^+ + \gamma + \gamma$ DECAY RATE. Kiems, J. H. (Univ. of California, Berkeley. Univ. of Chicago); Hildebrand, R. H.; Stiening, R. Phys. Rev. Lett.; 25: 473-4(17 Aug 1970).

The branching ratio for the process $K^+ \to \pi^+ + \gamma + \gamma$ is shown by a counter-spark-chamber experiment to be less than 4×10^{-6} of all decay modes, assuming a phase-space pion energy spectrum. A limit of 4×10^{-6} is established for the process $K^+ \to \pi^+ + \gamma$. The apparatus was sensitive to pions in the kinetic energy range 117-127 MeV. (auth)

40247 S-MATRIX ANALYSIS OF K_{l3} FORM FACTORS: ZERO OF THE SCALAR FORM FACTOR AND THE PARAMETER ξ. Kang, Kyungsik (Brown Univ., Providence). Phys. Rev. Lett.; 25: 414-18(10 Aug 1970).

An S-matrix calculation of the K_{l3} form factors, which can explain the parameter $\xi \simeq -1$ of the more recent polarization measurements, is presented. Existence of a zero in the scalar form factor near the K_{l3} physical region and below the Kπ threshold plays an important role. It is shown further that the theoretical arguments based on the soft-meson theorems are inadequate to predict such a zero in the scalar form factor irrespective of the symmetry-breaking patterns employed. Implications of the zero to the off-mass-shell extrapolation of the form factors are briefly discussed. (auth)

Strong (Baryon-Induced)

40248 (COO-1428-208) REVIEW OF S = −1 BARYON STATES AS OBSERVED IN PRODUCTION EXPERIMENTS. Miller, David H. (Purdue Univ., Lafayette, Ind.). [1970]. 45p. (CONF-700416-2). Dep. CFSTI.

From International Conference on Hyperon Resonances, Durham, N. C.

The published data on S = −1 baryon states seen in production experiments are reviewed. Concentration is placed on states which are less well established, and the Y* particles are discussed in order of ascending mass. It is found that the number of states observed in production experiments is small compared to the phase shift data. (J.F.P.)

40249 (ORNL-tr-2347) PRODUCTION OF CHARGED PIONS BY COLLISION OF ~600 MeV NEUTRONS WITH THE NUCLEI OF VARIOUS ELEMENTS. II. DISCUSSION OF EXPERIMENTAL RESULTS. Oganesyan, K. O. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated for Oak Ridge National Lab., Tenn., from report JINR-P1-3400. 28p. Dep. CFSTI.

A qualitative explanation is given of the fundamental laws of pion production in nuclei by analyzing the set of experimental data obtained in the bombardment of nuclei by neutrons and comparing them with available data for proton beams. (J.F.P.)

40250 (UCRL-19765) Λ(1520) REVISITED. Tripp, Robert D. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1970. Contract W-7405-eng-48. 18p. (CONF-700416-5). Dep. CFSTI.

From International Conference on Hyperon Resonances, Durham, N. C.

The experimental data in the vicinity of the Λ(1520) are reviewed. This review includes the production, decay, and branching ratio for this resonance. The experimental phenomena for $K^- + p$ interactions near this resonance are also discussed. (J.F.P.)

40251 ELASTIC SCATTERING OF PROTONS ON DEUTERONS AT HIGH ENERGY. Bradamante, F.; Fidecaro, G.; Fidecaro, M.; Giorgi, M.; Palazzi, P.; Penzo, A.; Piemontese, L.; Sauli, F.; Schiavon, P.; Vascotto, A. (CERN, Trieste, Italy). Phys. Lett.; 32B: 303-8(6 Jul 1970).

The differential cross-section for pd elastic scattering was measured at 9.7, 12.8 and 15.8 GeV/c for t-values up to -2 GeV^2. The Glauber multiple scattering model was used to analyze the data, the main interest being the double scattering region. (auth)

40252 GENERATION OF THE NUCLEON ISOBAR IN INTERACTION OF 24-GeV/c MOMENTUM PROTONS WITH THE NUCLEUS OF PHOTOEMULSION. Galstyan, G. A. (Erevan Inst. of Physics). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 4: 352-7 (1969). (In Russian).

The isobar generation in p−N interaction with 24 GeV/c momentum was investigated by means of the nuclear photoemulsion method in a strong magnetic field. An isobar of 1.24 GeV/c^2 was observed. The angular distribution of p and π-meson from N* (1.24 GeV/c^2) with $\gamma^* \geq 10$ in c.m.s. is symmetrical and anisotropic, which agrees with spin $3/2$ for the isobar. The angular distributions of slow isobar ($\gamma^* < 10$) decay are asymmetrical, protons being ejected backward, but π-mesons forward. (auth)

40253 NEUTRON–PROTON COINCIDENCE MEASUREMENT FROM THE NEUTRON-INDUCED BREAKUP OF THE DEUTERON. Valkovic, V.; Furic, M.; Miljanic, D.; Tomas, P. (Ruder Boskovic Inst., Zagreb). Phys. Rev., C; 1: 1221-5(Apr 1970).

A method for measuring neutron-charged-particle coincidences from the 14.4-MeV neutron-induced reaction is developed. The n + d → p + n + n reaction is studied by the coincidence detection of the outgoing proton and neutron. The cross section is measured as a function of five independent kinematic variables. A contribution of neutron-proton quasifree scattering is observed. The cross section for $\Theta_n = \Theta_p = 30°$ is found to be $\sigma = 37.5 \pm 5.8$ mb/sr^2. This result is in fair agreement with the data for proton-proton quasifree scattering from the p + d → p + p + n reaction. The possibility of obtaining a proper a_{nn} value is discussed. (auth)

40254 DEUTERON–DEUTERON ELASTIC SCATTERING AT 2.2 AND 7.9 GeV/c: EXPERIMENTAL STUDY. Goshaw, A. T. (Palmer Physical Lab., Princeton, N. J.); Oddone, P. J.; Bazin, M. J.; Sun, C. R. Phys. Rev. Lett.; 25: 249-53(27 Jul 1970).

Differential scattering data were obtained in bubble-chamber exposures and are compared with theoretical predictions using the Glauber multiple scattering theory. The effect of the quadrupole deformation of the deuteron and the influence of the various orders of multiple scattering are put in evidence. Agreement theoretical predictions and experiment is very good at the higher energy. At the lower energy, agreement is good only for momentum transfers below 0.2 (GeV/c)^2. Possible reasons for the disagreement above 0.2 (GeV/c)^2 are explored. (auth)

40255 MUTUAL COMMUTATION RELATIONS AND CONDITION OF UNITARITY OF THE S MATRIX. Andriambololona, Raoelina; Bourrely, Claude (Univ. Madagascar, Tananarive). Compt. Rend., Ser. B; 270: 1173-5(11 May 1970). (In French).

It is shown on a model of self-interacting fermion-antifermion field (Fermi interaction) that the mutual commutation relations of the field operators give exactly the same condition as that imposed by the unitarity of the fermion-antifermion elastic scattering matrix. (auth) (France)

40256 FOUR-BODY STRANGE-PARTICLE PRODUCTION IN pp COLLISIONS AT 6 GeV/c. Klein, S. (Univ. of California, Berkeley); Chinowsky, W.; Kinsey, R. R.; Mandelkern, M.; Schultz, J.; Tan, T. H. Phys. Rev., D; 1: 3019-30(1 Jun 1970).

An exposure of the LRL 72-in. liquid-hydrogen bubble chamber to 6-BeV/c protons has yielded 3000 examples of production of strange particles in four-body final states. Cross sections for the reactions pp → $\Lambda pK^0\pi^+$, pp → $\Lambda pK^+\pi^0$, and pp → $\Lambda nK^+\pi^+$ are 64 ± 6 μb, 39 ± 6 μb, and 43 ± 4 μb, respectively. The resonances K*(890), N*(1236), and Y*(1385) are produced with cross sections $\sigma(pK^{*+}) = 9 \pm 3$ μb, $\sigma(\Lambda^0 K^0 N^{*++}) = 23 \pm 3$ μb, $\sigma(\Lambda K^+ N^{*+}) = 4 \pm 2$ μb, $\sigma(pK^0 Y^{*0}) = 11 \pm 2$ μb, $\sigma(pK^+ Y^{*0}) = 7 \pm 1$ μb, and $\sigma(nK^+ Y^{*+}) = 15 \pm 2$ μb. Except for the low-Kπ-effective-mass region, the data are found to be in good agreement with a pion-exchange model. (auth)

40257 POLARIZATION OF INELASTIC NEUTRONS PRODUCED IN THE COLLISION OF 3-GeV PROTONS WITH PLATINUM. Bartlett, D. F. (Princeton Univ., N. J.); Cheng, D. C.; Friedberg, C. E.; Goulianos, K.; Hammerman, I.; Hutchinson, D. P. Contract AT(30-1)-2137. Phys. Rev., D; 1: 3087-90 (1 Jun 1970).

The polarization of neutrons produced in the collision of an unpolarized 3-GeV proton beam with a Pt target was measured. The neutrons studied had kinetic energies of 300, 430, and 570 MeV and were emitted at an angle of 34° to the left of the incident proton beam. The polarization of these neutrons was deduced from a measurement of the left-right asymmetry in a subsequent charge-exchange scattering off a hydrogen target. At the above neutron energies, neutron polarizations of +0.056 ± 0.023, +0.035 ± 0.027, and +0.043 ± 0.018, respectively were found. The plus sign indicates an upward polarization. (auth)

Strong (Meson-Induced)

Refer also to abstracts 40243, 40245, and 40386.

40258 (COO-1195-186) FEATURES OF THE K^+d REACTION AT 3.8 GeV/c. Eisenstein, B.; Gordon, H.; Kim, J.; Marshall, D.; Moninger, W.; O'Halloran, T.; Robinson, M.; Schultz, P. (Illinois Univ., Urbana. Dept. of Physics). Jun 1970. 14p. (CONF-700806-18). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

A study is reported of 761 events of the reaction $K^+d \to K^+\pi^-\pi^+d$ at 3.8 GeV/c. This reaction shows strong production of $K^{*0}(890)$ and also of the d^{*++} effect. The $K^+\pi^-\pi^+$ mass spectrum displays clear evidence for an enhancement at 1.30 GeV/c^2 with a full width at half maximum of 54 MeV/c^2. This "narrow Q" enhancement is superimposed on a much broader background which peaks at about 1.15 GeV/c^2. The narrow Q is primarily associated with events in which the d^{*++} effect is not present. The broad background is described well by a Reggeized pion exchange model applied to the reaction $K^+d \to K^{*0}\pi^+d$. The narrow Q probably has

$J^P = 1^+$. Also Q production seen in the final states $K^0\pi^+\pi^0$d and $K^+\pi^+\pi^-$pn is briefly described. Preliminary results of a study of the reaction K^+d → K^+pp are given. The differential cross section is compared to a ρ, ρ′, A_2 exchange model. (auth)

40259 (COO–1195–188) THE REACTION π^-p → pπ^- ω^0 AT 5.0 AND 7.5 GeV/c. Ascoli, G.; Bridges, C. A.; Brockway, D. V.; Crawley, H. B.; Eisenstein, L. B.; Hanft, R. W.; Ioffredo, M. L.; Kruse, U. E. (Illinois Univ., Urbana. Dept. of Physics). Jun 1970. 8p. (CONF-700806-20). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

Some results on the production of the B meson in the reaction $\pi^- + p \rightarrow \pi^- + \omega^0 + p$ at 5.0 and 7.5 GeV/c in hydrogen bubble chambers are presented. The mass and width of the B meson are determined, and also the spin and parity are found from the decays $B \rightarrow \omega^0 + \pi^-$, $\omega^0 \rightarrow \pi^+ + \pi^- + \pi^0$. (J.F.P.)

40260 (COO–1195–191) K^+p ELASTIC SCATTERING AT 2.53, 2.76, AND 3.20 GeV/c. Abrams, G. S.; Eisenstein, L.; Kim, J.; O'Halloran, T. A.; Shufeldt, W.; Whitmore, J. (Illinois Univ., Urbana). Apr 1970. 8p. (CONF-700416-3). Dep. CFSTI.

From International Conference on Hyperon Resonances, Durham, N. C.

The resonance at 2.505, which was previously reported, was studied in elastic $K^+ + p$ interactions at 2.53, 2.76, and 3.20 GeV/c in a hydrogen bubble chamber. Also preliminary results of a phase shift analysis at 2.53 GeV/c are presented. (J.F.P.)

40261 (COO–1428–175) OBSERVATION OF N*(1720) DECAY TO Δ(1236)π FROM π^+p INTERACTIONS AT 13.1 GeV/c. Willmann, R. B.; Lamsa, J. W.; Gaidos, J. A.; Ezell, C. R. (Purdue Univ., Lafayette, Ind.). [1969]. 13p. Dep. CFSTI.

Evidence is presented for the production of N*(1720) (M = 1719 ± 6 MeV, Γ = 63 ± 12 MeV) and subsequent decay to Δ(1236)π in π^+p interactions at 13.1 GeV. Analysis of the sequential decay $N^*(1720) \rightarrow \Delta^{2+}\pi^- \rightarrow p\pi^+\pi^-$ limits the spin to ½ or ⅞, with ⅞ favored. If only the lower l wave contributes to the decay, $J^P = ⅞^-$. (auth)

40262 (COO–1428–216) REACTION π^+p → $\rho^0\Delta^{++}$ AT 13.1 GeV/c. Gaidos, J. A.; Willman, R. B.; Lamsa, J. W.; Ezell, C. R. (Purdue Univ., Lafayette, Ind. Dept. of Physics); Meiere, F. T. (Indiana-Purdue Univ., Indianapolis. Dept. of Physics). [1969]. 15p. (CONF-700806–1). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

The differential cross section and ρ density matrix elements for the reaction π^+p → $\rho^0\Delta^{++}$ at 13.1 GeV/c are presented. The data are interpreted in terms of an absorption model with conventional pion exchange. The transverse ρ^0 production is compared with the predictions of vector dominance. (auth)

40263 (IFA-HE-65) Ξ^- HYPERON PRODUCTION IN π^-–N INTERACTIONS. Coca, C.; Mihul, A. (Institutul de Fizica Atomica, Bucharest (Romania)). 1970. 13p. Dep. CFSTI.

An attempt is made to analyze the experimental data available on Ξ^- production in π^-N interactions. (auth)

40264 (JINR-P1-5072) π-N AND COHERENT INTERACTIONS OF π-MESONS IN PHOTOEMULSION AT 45 AND 60 GeV/c. Anzon, Z. V.; Vinitskii, A. Kh.; Voinov, V. G.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1970. 32p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The results of investigation of π-N inelastic interactions at 45 and 60 GeV/c, including multiplicity of charged particles, distribution over multiplicity and angular distributions, are presented. The data on coherent generation of particles by the photoemulsion nuclei are obtained. It is shown that the cross section of this process increases with increasing π^--meson energy. (auth)

40265 (NEVIS–182) A SEARCH FOR EVIDENCE OF ω → $\pi^+\pi^-$ IN π^-p → $\pi^+\pi^-$n AND A STUDY OF THE ω → $\pi^+\pi^-\pi^0$ DALITZ PLOT. Nash, Thomas (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). 1970. Contract AT(30-1)-1932. 132p. (CU–286; R–717). Dep. CFSTI.

Thesis.

Evidence of ω → $\pi^+\pi^-$ was sought in a sample of 9696 π^-p → $\pi^+\pi^-$n events taken at a beam momentum of 1245 MeV/c. The branching ratio, $B = N_{\omega\to 2\pi}/N_{\omega\to 3\pi}$, was measured for a series of assumptions of ρ-ω coherence and relative phase angle, φ. The results set upper limits at the 90% confidence level of B < 2.9% for incoherence, B < 17.9% for coherence and destructive interference ($\phi = +(\pi/2)$), B < 0.51% for constructive interference ($\phi = -(\pi/2)$), and B < 3.0% for φ = π. Also the Dalitz plot asymmetry of an accompanying sample of about 7600 ω → $\pi^+\pi^-\pi^0$ events in π^-p → $\pi^+\pi^-\pi^0$ to be A = −0.014 ± 0.028 was measured. The nonresonant background was subtracted from these data in 28 independent Dalitz plot regions. The Dalitz plot distribution of the ω events agrees very well with the simplest matrix element for a $J^P = 1^-$ particle and shows no evidence of any ρ dominance effects. (auth)

40266 (NYO–2262–TB–152) RESEARCH PROGRAM IN EXPERIMENTAL HIGH ENERGY PHYSICS. Progress Report. Shapiro, Anatole M.; Lanou, Robert E. Jr. (Brown Univ., Providence, R. I. Dept. of Physics). 1 Jun 1970. Contract AT(30-1)-2262. 17p. Dep. CFSTI.

A brief review of research on hadron interactions and properties is reported. A list of publications is included. (J.F.P.)

40267 (ORO–2504–158) INVESTIGATIONS ON THE PROPERTIES OF K MESONS AND HYPERONS AND RELATED TOPICS IN HIGH ENERGY PHYSICS. Progress Report, October 1, 1969–September 30, 1970. Technical Report No. 70-119. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Jun 1970. Contract AT(40-1)-2504. 53p. Dep. CFSTI.

A brief review of research in high-energy physics is presented. This research covers bubble chamber, counter, and spark chamber experiments and is primarily concerned with K mesons and hyperons. A list of publications is included. (J.F.P.)

40268 (ORO–3065–22) SEARCH FOR Λ(1330) IN K^-, p INTERACTIONS AT 740 MeV/c. Binkley, M. E.; Carpenter, D. W.; Elliott, J. R.; Fortney, L. R.; Fowler, E. C.; Golson, J. P.; Kronenfeld, J. E.; Rose, C. M.; Snow, T. R.; Yeager, W. M. (Duke Univ., Durham, N. C. Dept. of Physics). [nd]. 7p. (CONF-700806–23). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

A search was made for a previously found resonance Λ(1237) in $K^- + p \rightarrow \Lambda(1237) + \pi^0$ interactions at 740 MeV/c in a hydrogen bubble chamber. This resonance was not found. (J.F.P.)

40269 (UCRL–19824) REMARKS ON THE EXISTENCE OF TWO Σ(1660) RESONANCES. Estes, Robert D.; Duboc, Jean; Eberhard, Philippe H.; Friedman, Jerome H.; Pripstein, Morris; Ross, Ronald R. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1970. Contract W-7405-eng-48. 4p. (CONF-700416-1). Dep. CFSTI.

From International Conference on Hyperon Resonances, Durham, N. C.

The quasi two-body reactions $K^- + p \rightarrow X^+ + \pi^-$ are studied in various K^- + p interactions obtained from an exposure of a hydrogen bubble chamber to a K^- beam from the Bevatron at 2.1 to 2.70 GeV/c. Special emphasis is placed on the X^+ mass region near 1660 MeV. These data are interpreted to imply the existence of two Σ(1660) resonances. (J.F.P.)

40270 PROTON–PROTON SCATTERING AT 9.690, 9.918, AND 13.600 MeV. Jarmie, Nelson; Jett, J. H.; Detch, J. L. Jr.; Hutson, R. L. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 25: 34–5(6 Jul 1970).

Adjustments to proton–proton elastic scattering data at 9.690 and 9.918 MeV have apparently resolved a discrepancy between the data and current energy-dependent phase-shift analyses. New data at 13.600 MeV are also presented and are compatible with the phenomenological analysis. These results indicate that the energy-dependent fitting of p + p data in the region of 10 MeV is now satisfactory. (auth)

40271 EXPERIMENTAL RESULTS OF MUONS STOPPING UNDERGROUND [(60 /4500) m w.e.]. Baschiera, B.; Bergamasco, L.; Castagnoli, C.; Picchi, P. (CNR, Turin). Lett. Nuovo Cim.; 4: 121–3(25 Jul 1970).

The search for low-energy muons at 60 to 4500 MWe was carried out using liquid scintillators and photomultipliers. The ratio of the stopping muon rate to the traversing muon rate was plotted as a function of energy. A large discrepancy is found between the calculated and experimental ratios. This discrepancy suggests a possible new leptonic process. Also the muon mean life from the decay curve slope was found to be 2.20 ± 0.05 μs. (J.F.P.)

40272 MEASUREMENT OF THE DIFFERENTIAL CROSS SECTION FOR THE REACTION $\pi^+ + p \rightarrow K^+ + \Sigma^+$ AND OF THE POLARIZATION OF THE Σ^+ FOR π^+ MOMENTA OF 3.00, 3.25, 4.00, 5.05, AND 7.00 GeV/c. Pruss, Stanley McQuaide. Ann Arbor, Mich.; Univ. of Michigan (1969). 72 p.

Thesis

The present understanding of the strong interaction between elementary particles at high energies indicates that exchange processes dominate the reaction amplitudes. An experiment is described which measured the differential cross section and hyperon polarization for the reaction $\pi^+ + p \rightarrow K^+ + \Sigma^+$ at several energies. Of the class of reactions in which hypercharge is exchanged, this reaction is the most convenient to measure. The experiment was done with wire spark chambers connected to an on-line computer.

These chambers are described in detail and it is explained how the data were analyzed on-line. (Diss. Abstr. Int., B)

40273 $\Lambda\pi^-$ PRODUCTION FROM K^- INTERACTIONS IN HELIUM. Bunnell, K. (Argonne National Lab., Ill. Northwestern Univ., Evanston, Ill.); Derrick, M.; Fields, T.; Hyman, L. G.; Keyes, G. Phys. Rev., D; 2: 98-118(1 Jul 1970).

Results are presented of a bubble-chamber study of the interaction of negative kaons with helium yielding $\Lambda\pi^-$ or $\Sigma^0\pi^-$ in the final state. Both low-momentum kaons and kaons at rest were used. In the at-rest sample, the two-step process $K^-N \to \Sigma\pi$ followed by $\Sigma N \to \Lambda N$ accounts for $(18 \pm 2)\%$ of the $\Lambda\pi^-He^3$ final state. Removing these $\Sigma-\Lambda$ conversion events, on the basis of the pion kinetic energy, gives spectra that are compared with an impulse model. A good fit to the data is obtained by using a Hulthén form factor, a mixture of atomic-orbital-capture states with $(71 \pm 9)\%$ s state and $(29 \pm 9)\%$ p state. For this fit, the S-wave $\bar{K}N$ amplitude determined by Kim is used, and the P-wave amplitude is assumed to be dominated by the $Y^*(1385)$ with the coupling to $\bar{K}N$ given by SU(3) symmetry. The same final state indicated by kaons in flight shows a good agreement with the predictions of the impulse model. No evidence is seen for a recently reported enhancement in the $\Lambda\pi^-$ system at 1440 MeV. The $\Lambda\pi^-$ pd final state is found to be dominated by the $\Sigma-\Lambda$ conversion process. Stopping-K^--reaction branching ratios and cross sections are calculated and compared with impulse-model predictions. No evidence is found for a Λn bound state, and an upper limit for its production is 5×10^{-4} per stopping K^-. (auth)

40274 STUDY OF THE REACTION $\pi^-p \to \pi^-\pi^-\pi^-\pi^+\pi^+p$ AT 3.9 GeV/c. Abe, K.; Johnson, A. D.; Stenger, V. J.; Wohlmut, P. G. (Univ. of Hawaii, Honolulu). Phys. Rev., D; 2: 91-7(1 Jul 1970).

459 events of the type $\pi^-p \to \pi^-\pi^-\pi^-\pi^+\pi^+p$ at 3.9 GeV/c were obtained. The cross section is found to be 0.115 ± 0.011 mb. Strong $\Delta^{++}(1236)$ production is observed, along with the production of ρ^0 in association with the $\Delta^{++}(1236)$. A statistically significant A_1^- signal is present. An anomalous enhancement is observed at 1.4-GeV $\pi^+\pi^+p$ mass which is mainly caused by the strong $\Delta^{++}(1236)$ production. No meaningful structure is seen in any of the four- or five-body invariant-mass spectra. The data have been fitted with a model of incoherent resonance production. (auth)

40275 K^+-PROTON ELASTIC CROSS SECTIONS AT 180° FROM 0.41 to 0.72 GeV/c. Caldwell, P. K.; Bowen, T.; Dikmen, F. Ned; Jenkins, E. W.; Kalbach, R. M.; Petersen, D. V.; Pifer, A. E. (Univ. of Arizona, Tucson). Phys. Rev., D; 2: 1-5(1 Jul 1970).

The K^+-p elastic scattering was measured in a small angular region near 180° ($-0.995 \geq \cos\theta^* \geq -1.0$) at six momenta from 0.41 to 0.72 GeV/c. The forward-scattered protons were detected with scintillation counters and identified by time-of-flight measurements. The K^+-p elastic differential cross section at 180° is found to be essentially constant with a value near 0.9 mb/sr. The sum of the P-wave phase shifts $(2\delta_{\frac{3}{2}} + \delta_{\frac{1}{2}})$ is found to be negative in this momentum region. The K^- elastic differential cross section is found to dip to a minimum $(0 \pm 0.2$ mb/sr) at 0.66 GeV/c. (auth)

40276 FINAL STATES WITH ONE OR TWO CHARGED PARTICLES AND A VISIBLE $\bar{K}^0$ FROM K^-d INTERACTIONS AT 4.5 GeV/c. Carmony, D. D. (Purdue Univ., Lafayette, Ind.); Eisner, R. L.; Ammann, A. C.; Garfinkel, A. F.; Gutay, L. J.; Miller, D. H.; Rangan, L. K.; Yen, W. L. Phys. Rev., D; 2: 30-45(1 Jul 1970).

A study of the interactions of 4.48-GeV/c K^- mesons on deuterium is reported. The 372,000-picture exposure was taken in the Argonne National Laboratory 30-in. deuterium-filled bubble chamber. The $\bar{K}^0$ final states from the one- and two-prong-plus-vee topologies are discussed. The final states investigated include (1) $\bar{K}^0\pi^-pn$, (2) $\bar{K}^0\pi^-d$, (3) $\bar{K}^0\pi^-\pi^0d$, (4) $\bar{K}^0\pi^-p$ (missing mass). Production of the $K^{*-}(890)$ resonance is analyzed from both K^--proton and K^--neutron interactions and is compared with absorption and Regge-pole models. The production of $\Delta^-(1236)$ in reaction (1) is compared with the predictions of Thews and with those of Maor and Krammer. Strong $K^{*-}(890)$ production occurs in reaction (2), and evidence for dominant-vector-meson exchange is given. The d^* enhancement is quite strong in (3), and K^*d^* production is discussed. (auth)

40277 π^-p BACKWARD ELASTIC SCATTERING FROM 2.38 TO 3.00 GeV/c. Crittenden, R. R.; Galloway, K. F.; Heinz, R. M.; Neal, H. A.; Sidwell, R. A. (Indiana Univ., Bloomington). Phys. Rev., D; 1: 3050-3(1 Jun 1970).

Differential cross sections are presented for backward π^-p elastic scattering in the angular region $-0.55 \geq \cos\theta_{c.m.} \geq -0.98$ for five incident momenta: 2.38, 2.50, 2.65, 2.80, and 3.00 GeV/c. The structure of the angular distribution undergoes a marked change over this momentum interval. A pronounced dip near 180°, which is seen for momenta $\lesssim$2.50 GeV/c, becomes a sharp peak at 2.80 and 3.00 GeV/c. A minimum in the cross section at $\cos\theta_{c.m.} \simeq 0.7$ is indicated at all momenta. In addition, a dip in the differential cross section appears at $\cos\theta_{c.m.} \simeq -0.92$ at 3.00 GeV/c. A good fit to the data from 2.1 to 3.0 GeV/c is obtained with a direct-channel resonance model. (auth)

40278 STUDY OF π^+p FOUR-PRONG INTERACTIONS FROM 2.95 TO 4.08 GeV/c. Brown, David (Univ. of California, Berkeley); Gidal, George; Birge, Robert W.; Fung, Sun-yiu; Jackson, Warren; Poe, Robert T. Phys. Rev., D; 1: 3053-76(1 Jun 1970).

In a study of the production mechanism of quasi-two-body final states at the five incident π^+ momenta 2.95, 3.2, 3.5, 3.75, and 4.08 GeV/c, approximately 40,000 events with four outgoing charged particles were investigated. The cross sections for the processes $\pi^+p \to N^{*++}\rho$, $\pi^+p \to N^{*++}\omega$, $\pi^+p \to N^{*++}\eta$, and $\pi^+p \to N^{*++}f$ were measured as a function of the pion energy. The differential cross sections and the decay density-matrix elements are discussed in terms of one-meson-exchange models [with absorption (OPEA) and with form factor (OPEW)] and Regge models. For the $N^{*++}\rho$ and the $N^{*++}\omega$ reactions, the joint-decay matrix elements are calculated. The formation of $N^*(2850)$ in the direct channel is also investigated. (auth)

40279 $\pi^-p \to \pi^-\pi^+\pi^-p$ REACTION AT 6 GeV/c. Galloway, K. F.; Mott, J. E.; Alyea, E. D. Jr.; Lee, K. Y.; Martin, H. J.; Prickett, W. F. (Indiana Univ., Bloomington). Phys. Rev., D; 1: 3077-86(1 Jun 1970).

A study of 2300 events representing the $\pi^-\pi^+\pi^-p$ final state produced by the interactions of 5.97-GeV/c π^- mesons with protons in the Argonne National Laboratory 30-in. hydrogen bubble chamber is reported. This final state has a cross section of 1.39 ± 0.15 mb and is dominated by ρ^0 production $(0.60 \pm 0.08$ mb) and $\Delta^{++}(1236)$ production $(0.39 \pm 0.06$ mb). There is evidence for the production of A_1 and $A_{1,5}$ mesons in the 3π mass spectrum in addition to the A_2. Some characteristics of the $\pi\rho p$ and the $\pi\pi\Delta$ final states can be explained with a double-Regge-exchange model. (auth)

40280 EXPERIMENTAL SEARCH FOR A BOUND (Σ^-n) DIBARYON STATE. Davis, Howard F.; Gustafson, H. Richard (Univ. of Washington, Seattle). Phys. Rev., D; 1: 2989-3009 (1 Jun 1970).

An experimental search for a bound (Σ^-n) state produced an upper limit on the $\pi^- + d \to K^+ + (\Sigma^-n)$ cross section. For $P_{\pi^-}{}_{lab} = 1.15$ GeV/c, $25° \lesssim \theta_{K^+}{}_{lab} \lesssim 60°$, and an experimental width of ± 10 MeV in the (Σ^-n) mass, the result is $\sigma \leq 0.16$ μb sr^{-1}, 90% confidence. This limit on the (Σ^-n) production cross section is compared with the prediction of the Henley–Dante impulse model for $^1S_0$ (Σ^-n) production; this comparison leads to an upper limit on the $^1S_0$ (Σ^-n) binding energy of 0.3 MeV, 90% confidence limit. (auth)

40281 STUDY OF THE DECAY PARAMETERS AND MAGNETIC MOMENT OF THE Ξ^-. Bingham, G. McD. (Univ. of Washington, Seattle); Cook, V.; Humphrey, J. W.; Sander, O. R.; Williams, R. W.; Masek, G. E.; Maung, T.; Ruderman, H. Phys. Rev., D; 1: 3010-18(1 Jun 1970).

An experimental study of the decay parameters and the magnetic moment of the Ξ^- is described. A 1.8-GeV/cK^- beam derived from the Bevatron was used to produce Ξ^- by the reaction $K^-p \to \Xi^-K^+$. The K^+ and resulting decay products of the Ξ^- were used to trigger a spark-chamber system, pictures from which yielded a total of 2724 events which passed all measuring criteria. The Ξ^- were produced in an intense (170 kG) magnetic field obtained from a pulsed magnet. The precession of the magnetic moment of the Ξ^- in the presence of this field can be measured from the angular distribution of the Ξ^- decay products and a value of the magnetic moment obtained. The decay parameters and polarization of the Ξ^- are also obtained from the angular distribution of the decay products; $\alpha = -0.383 \pm 0.065$, $\phi = -(26 \pm 30)°$, and $\bar{P} = 0.19 \pm 0.09$ are obtained. The accuracy of the magnetic moment value is severly limited by the low value of polarization and experimental biases in the distribution; $\mu_{\Xi^-} = -0.1 \pm 2.1$ nuclear magnetons is obtained. (auth)

40282 DECAY OF SOME HIGH-MASS BOSONS TO $\pi^+\pi^0$. Kramer, S. L.; Barton, H. R.; Gutay, L. J.; Lichtman, S.; Miller, D. H.; Scharenguivel, J. H. (Purdue Univ., Lafayette, Ind.). Phys. Rev. Lett.; 25: 396-400(10 Aug 1970).

Evidence is presented for three boson structures with masses 1.65, 1.97, and 2.16 GeV/c^2 and widths less than 80 MeV/c^2 from a study of the reaction $\pi^+p \to p\pi^+\pi^0$ at 13.1 GeV/c. These structures are shown to have $I^G = 1^+$, therefore excluding even J assignments. This result favors the interpretation of the 1.97 state as a member of the A_2 daughter trajectory. (auth)

40283 SEARCH FOR T = 1 BOSONS NEAR 1 GeV IN THE REACTION pp → d + MM. Abolins, M. A. (Lawrence Radia-

tion Lab., Berkeley, Calif.); Graven, R.; McCarthy, R.; Smith, G. A.; Smith, L. H.; Wicklund, A. B.; Lander, R. L.; Pellett, D. E. Phys. Rev. Lett.; 25: 469-73(17 Aug 1970).

A wire-spark-chamber deuteron spectrometer was used to measure the missing-mass (MM) spectrum up to ~1.5 GeV in the reaction $pp \rightarrow d + MM$ for deutrons produced at 0° in the laboratory and incident momenta of 3.8, 4.5, and 6.3 GeV/c. Production cross sections for π and ρ are reported. Evidence of $\pi_N(980)$ production with mass 975 ± 6 MeV and width $60^{+\infty}_{-6}$ MeV is presented. No other statistically significant enhancements were found. (auth)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 39737.

General

40284 (DESY-70/22) ON THE VALIDITY OF WARD IDENTITIES. Stichel, P. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1970. 29p. Dep. CFSTI (U. S. Sales Only).

Ward identities for matrix elements of covariant two-point time-ordered operators in the presence of an arbitrary number of subtractions are investigated. Neither the existence of naive T-products nor the existence of equal-time commutators between current densities will be assumed. It is shown by means of the Jost-Lehmann-Dyson representation that T-products can always be defined such that normal Ward identities with respect to one current are valid. The simultaneous validity of normal Ward identities with respect to two currents requires a relation between equal-time charge-current commutators. The results show that the usual realization of current algebra in the form of Ward identities is possible even if subtractions are necessary. Some examples are discussed in detail. (auth)

40285 SIMPLE AND GENERAL DERIVATION OF THE ANGULAR CONDITION ON CURRENT ALGEBRAS AT INFINITE MOMENTUM. Divakaran, P. P.; Mukunda, N. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., D; 2: 405-7 (15 Jul 1970).

A simple derivation is presented of the angular condition on current algebra at infinite momentum, wide enough to cover the possible presence of spacelike states. The use of the Breit frame, which is not in general possible if spacelike states are involved, is completely avoided. (auth)

40286 K-MATRIX MODEL FOR POMERANCHUK EXCHANGE. Drechsler, Wolfgang (Stanford Univ., Calif.). Phys. Rev., D; 2: 364-76(15 Jul 1970).

Starting from the assumption that the inelastic states in the unitarity relation can effectively be represented by a set of quasi-two-particle states, a K-matrix formalism is set up for high-energy elastic scattering and diffraction-dissociation processes. Using arguments similar to those of Freund, it is shown that the Pomeranchuk contribution to elastic scattering and diffraction dissociation can be generated by multiple exchange of an exchange-degenerate quantum number carrying Regge trajectory R, by considering at the same time a formation of a sequence of excited intermediate states of the colliding particles between the individual R exchanges. This unitarization procedure leads to an imaginary as well as a real contribution for vacuum exchange, corresponding basically to sums of double and triple R-exchange contributions, respectively. At the same time, the K-matrix formalism produces an absorptive correction to the input Born terms. The consequences of the proposed model are worked out, particularly as regards the asymptotic behavior of total cross sections and the interpretation of the crossover phenomenon. (auth)

40287 COMPOSITENESS CRITERION FOR UNSTABLE PARTICLES. Passi, J. N. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., D; 2: 310-12(15 Jul 1970).

The problem of making unstable elementary particles equivalent to resonances is investigated in a soluble model field theory. It is demonstrated that the irreducible part of the scattering amplitude develops a pair of complex conjugate poles on the second sheet of the energy plane, one of them corresponding to an S-wave resonance. The poles in the vertex and inverse propagator induced by these complex poles of the irreducible part of the scattering amplitude are such that the so-called Jin-MacDowell cancellation holds good. It is shown that under the conditions $Z_1 = 0$ and $Z_2 = 0$, the S-wave resonance completely replaces the unstable particle. (auth)

40288 CLASSICAL CHARGED TACHYON SELF-ENERGY PROBLEM. Cawley, Robert G. (Naval Ordnance Lab., Silver Spring, Md.). Phys. Rev., D; 2: 276-7(15 Jul 1970).

The classical self-energy problem for charged tachyons is more serious than that for charged bradyons. As a result, the theoretical basis for generally expected experimental properties of such objects is shaky. (auth)

40289 TACHYONIC ANTITELEPHONE. Benford, G. A.; Book, D. L.; Newcomb, W. A. (Univ. of California, Livermore). Phys. Rev., D; 2: 263-5(15 Jul 1970).

The problem of detecting faster-than-light particles is reconsidered in relation to Tolman's paradox. It is shown that some of the experiments already under way or contemplated must either yield negative results or give rise to causal contradictions. (auth)

40290 HIGH ENERGY PHYSICS INDEX. VOLUME 8, NO. 14, 16 JULY 1970. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 67p.

40291 SYMPOSIA ON THEORETICAL PHYSICS AND MATHEMATICS. VOLUME 10. Lectures Presented at the 1969 Seventh Anniversary Symposium of the Institute of Mathematical Sciences, Madras, India, January 1969. Ramakrishnan, Alladi (ed.). New York; Plenum Press (1970). 169p. $15.00. (CONF-690125).

The conference included 16 lectures one of which was abstracted previously in NSA. For an abstract of this lecture see abstract number 24: 15992. Separate abstracts were prepared for seven lectures. Other lectures were concerned with contributions of Ramanujan to mathematics, regularly varying functions and Poincaré theorem on difference equations, operators on Hilbert space, close-to-convex functions, uniqueness theorems, Ramanujan function, fixed-point theorems, and a group theoretical connection among the physical hierarchies. (J.F.P.)

For abstracts of individual lectures see: 40370, 40437-40439, 40462, 40498, and 40712.

40292 CARRUTHERS' THEOREM FOR ANY SPIN AND PARASTATISTICS. Seetharanan, M.; Jayaraman, J.; Mathews, P. M. (Univ. of Madras). Nuovo Cim.; 68A: 409-12(1 Aug 1970).

It is shown that Carruthers' theorem (that particle multiplets of half-integral isospin cannot be self-conjugate) holds even for particles which obey the general parastatistics instead of the usual Bose or Fermi statistics. (auth)

40293 ENERGY LOSS OF HIGH-ENERGY PARTICLE PAIRS IN MATTER. Trefil, J. S. (Univ. of Illinois, Urbana). Phys. Rev., D; 2: 128-33(1 Jul 1970).

Problems associated with the passage of high-energy charged-particle pairs through matter (the Chudakoff effect) are investigated. It is shown that such an effect could not produce lightly ionized tracks which would be mistaken for quarks in cosmic-ray experiments. Treatments of polarization of the medium and Landau straggling are given. (auth)

40294 RELATIONSHIP BETWEEN THE ELASTIC FORWARD SCATTERING AMPLITUDES FOR THE PARTICLE AND ANTIPARTICLE AT FINITE ENERGIES. Vernon, Yu. S. (Lebedev Inst. of Physics, Moscow). Teor. Mat. Fiz.; 4: 3-6(Jul 1970). (In Russian).

Using the general postulates the following relation is proved: $\left|\int_{E_1}^{E_2} \ln\left|[f_+(E')]/[f_-(E')]\right|(dE')/(E')\right| < \pi^2$. Here $f_+(E)[f_-(E)]$ is the elastic forward scattering amplitude for the particle (antiparticle), E_1, E_2—arbitrary energies in l.s. Amplitudes $f_\pm(E)$ are proved to have no zeros in the complex plane of E. (auth)

40295 HIGH ENERGY PHYSICS INDEX. VOLUME 8, NO. 13, 2 July 1970. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 65p.

40296 HIGH ENERGY PHYSICS INDEX. VOLUME 7, 1969. Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1969). 516p.

40297 HIGH ENERGY PHYSICS INDEX. VOLUME 8, NO. 15, 2 AUGUST 1970. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 57p.

Electromagnetic

Refer also to abstract 40230.

40298 (INR-P-1166) RHO-PHOTON COUPLING CONSTANT AND THE RHO-NUCLEON SCATTERING AMPLITUDE. Staszel, M.; Wilk, G. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 11p. Dep. CFSTI (U. S. Sales Only).

Some recent data on the ρ^0 photoproduction on nuclei were analyzed in terms of Glauber model of multiple scattering in

order to calculate the value of the rho-photon coupling constant. The numerical results depend on the assumed value $\alpha_{\rho N}$ of the ratio of the real to the imaginary part of the elementary rho-nucleon scattering amplitude. For $|\alpha_{\rho N}| = 0.3$, which is a reasonable assumption, one obtains results consistent with the value of $\gamma_\rho^2/4\pi = 1.0$, obtained at SLAC from the different analysis of the same data. (auth)

40299 NONHADRONIC INTERACTIONS IN THE DUAL RESONANCE MODEL. Kikkawa, K.; Sato, h. (Tokyo Univ.). Phys. Lett.; 32B: 280-4(6 Jul 1970).

Assuming the minimal gauge principle a method to incorporate the gauge bosons into the dual resonance scheme is presented. The photon and the weak boson interaction vertices with the hadrons are given in a factorized form in terms of an operational formalism. (auth)

40300 ANALYSIS OF AMPLITUDES OF ONE-MESON PHOTOPRODUCTION IN ENERGY REGION OF THE SECOND RESONANCE. Moroz, L. G.; Maksimenko, N. V. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 1, 97-101(1969). (In Russian).

Experimental data were used for evaluating the amplitude of π-meson photoproduction in the region of the second resonance and the relative contribution of multipole amplitudes were determined. It is shown that within the limits of the resonance model previously suggested by Peierls and Vergeneiacis model of photoproduction in the region of second resonance energy does not agree with the observed peculiarities of the process. (R.V.J.)

40301 WHY IS N*(1470) NOT OBSERVED IN PHOTOPRODUCTION EXPERIMENTS? Barut, A. O.; Nagylaki, T. (Univ. of Colorado, Boulder). Lett. Nuovo Cim.; 4: 157-60(25 July 1970).

It is shown that the failure for the Roper resonance to be produced in electromagnetic interactions is due to a dynamical suppression in the relativistic O(4,2) model of baryons. The cross section ratio of the photoproduction of the N(1550) to that of the Roper resonance is estimated. It is concluded that one should not easily observe the Roper resonance in an h photoproduction process. (J.F.P.)

40302 CALCULATION OF THE ENERGY DEPOSITED IN THICK TARGETS BY HIGH-ENERGY (1 GeV) ELECTRON–PHOTON CASCADES AND COMPARISON WITH EXPERIMENT. II. Alsmiller, R. G. Jr.; Moran, H. S. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng.; 40: 483-5(Jun 1970).

Calculated results similar to those previously given for electron-photon cascades induced in thick targets of aluminum and water by 1-GeV electrons, but including the density-effect correction are presented and compared with experimental data. (J.F.P.)

40303 ANALYSIS OF THE LOW-ENERGY NUCLEON–NUCLEON BREMSSTRAHLUNG. Liou, M. K.; Cho, K. S. (Univ. of Manitoba, Winnipeg). Nucl. Phys.; A145: 369-77 (1970).

Under the assumption that two nucleons interact via a static two-body potential, a method of deriving an analytic expression for the rescattering amplitude M_{fi} is presented. The present method, which is the modification of a previous method, is then applied for the neutron-proton bremsstrahlung process. It was shown that the derived amplitude does satisfy the assumption of the low-energy theorem and the gauge condition in the low-energy region where the S-wave dominates. Various cross sections for the proton-proton and neutron-proton bremsstrahlung processes are calculated and compared with the available experimental data and other theoretical calculations. (auth)

40304 DEEP-INELASTIC ELECTROPRODUCTION AND CONFORMAL SYMMETRY. Boulware, David G.; Brown, Lowell S.; Peccei, R. D. (Univ. of Washington, Seattle). Contract AT(45-1)-1388. Phys. Rev., D; 2: 293-8(15 Jul 1970).

Motivated by the observed scale invariance of high-energy inelastic electron–proton scattering, a study is made of the constraints on a Compton amplitude that follow if it is invariant under the full group of conformal coordinate transformations. Although the conformal group contains operations that interchange spacelike and timelike coordinate intervals, a large class of manifestly causal amplitudes can be constructed. It is found that the strict application of conformal symmetry reduces the number of independent covariants from four to two in the case of a spin-zero target. The two covariants of the conformal Compton amplitude remain independent when it is restricted to forward scattering. Hence, invariance under the full conformal group yields no constraints on the structure functions of inelastic electron scattering other than that already provided by simple dilation invariance. (auth)

40305 ELECTROMAGNETIC MASS IN FIVE-DIMENSIONAL THEORY. Bedritskii, A. I. Dokl. Akad. Nauk BSSR; 14: 220-2 (Mar 1970). (In Russian).

On the basis of five-dimensional theory with certain assumptions, it is possible to calculate the maximum possible ratio m_1/m_0 for separate cases of the distribution of electric charge over the volume of the particle, at the same time excluding r_0. In the five-dimensional theory there is introduced the internal parameter of the particle x_5 with period l_5 having the dimension of length and characterizing the particle mass state. The introduction of this parameter is an attempt to reflect in theory as repeatedly stressed by a number of investigators the interdependence of internal and external symmetries of elementary particles. (tr-auth)

40306 SUGAWARA'S THEORY AND e^+–e^- ANNIHILATION INTO HADRONS. Clement, G. (College de France, Paris). Lett. Nuovo Cim.; 3: 749-52(13 Jun 1970).

A new result relating to the high-energy behavior of the total cross section $e^+ + e^- \rightarrow$ hadrons is derived in the framework of the Sugawara field theory of currents. This result is different from the behavior usually and incorrectly assumed to follow from the Sugawara theory. (J.F.P.)

40307 T-INVARIANCE IN ELECTRON–DEUTERON ELASTIC SCATTERING. Ferrara, S.; Grillo, A. F. (CNEN, Frascati, Italy). Lett. Nuovo Cim.; 4: 31-4(4 Jul 1970).

It is shown in the impulse approximation that the time-reversal invariance in the electromagnetic transition of the deuteron implies that the phase of 0° at 180°. Thus there is no discrepancy between a previous result (in which it was suggested that an effect of polarization can be present in the absence of a T-violating electromagnetic interaction if a phase between the S and D states of the deuteron is present) and the general conclusion obtained from the Lorentz invariance requirement on the electromagnetic vertex of a spin-one particle. (J.F.P.)

40308 HADRON PRODUCTION IN e^+e^- COLLISIONS. Cabibbo, N. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Parisi, G.; Testa, M. Lett. Nuovo Cim.; 4: 35-9(4 Jul 1970).

A field theoretical treatment of the parton model for e + p deep inelastic scattering was previously given. For this treatment some experimentally observed properties for the process were recovered. This previous method is extended to the study of the total cross section of electron-positron annihilation into hadrons. (J.F.P.)

40309 e^+e^- ANNIHILATION INTO HADRONS. Ferrara, S.; Greco, M.; Grillo, A. F. (CNEN, Frascati, Italy). Lett. Nuovo Cim.; 4: 1-3(4 Jul 1970).

Predictions on $e^+ + e^-$ annihilation into hadrons are given. These predictions are based on a statistical model for inelastic e + p scattering and the parton theory of hadron electromagnetic interactions. (J.F.P.)

40310 TWO-PION DECAY MODE OF THE ω AND ρ–ω MIXING. Sachs, Robert G.; Willemsen, Jorg F. (Univ. of Chicago). Phys. Rev., D; 2: 133-8(1 Jul 1970).

Recent experiments reporting the 2π decay mode of the ω meson and its interference with that mode of the ρ meson are analyzed in terms of the propagator method for mixing of particle states. Both vector mixing and mass mixing are included, and the energy dependence of the ρ width is explicitly taken into account. It is shown that the effect as observed in the reaction $e^+e^- \rightarrow \pi^+\pi^-$ can be accounted for in terms of available parameters. The consequent determination of the parameters makes possible an analysis of strong-interaction phenomena of the same type, giving information on the relative phases of ω and ρ production amplitudes. This is applied to the $\rho-\omega$ interference observed in $\pi^+p \rightarrow \pi^+\pi^-\Delta^{++}$. Other experiments are suggested. (auth)

40311 NEUTRAL-PION DECAY AND THE WEAK-COUPLING LIMIT. Scadron, Michael D. (Northwestern Univ., Evanston, Ill.). Phys. Rev., D; 2: 213-17(1 Jul 1970).

An exact version of Pagels' sum rule for neutral-pion decay is derived for massless pions. It is inconsistent, however, in the weak-coupling limit. If this limit is modified by including the σ meson, then the sum rule is consistent and also yields the physically reasonable relation $\kappa_p = -\kappa_n$. (auth)

40312 LOW-t THEOREMS FOR CHARGED-PION PHOTOPRODUCTION. Campbell, J. A. (Univ. of Texas, Austin); Clark, Robert Beck; Horn, D. Contract AT(11-1)-68. Phys. Rev., D; 2: 217-24(1 Jul 1970).

Low-t theorems for charged-pion photoproduction are proven

on the basis of gauge-invariance restrictions. They can be simply formulated by means of the minimal gauge-invariant extension of pion exchange (MPE). It is shown that whereas MPE leads in $\gamma N \to \pi^+ N$ only to weak restrictions for $d\sigma/dt$ near the forward direction ($|t| \leq \mu^2$), it does actually account for all the structure observed in $\gamma p \to \pi^- \Delta^{++}$ in this t domain. Results for these reactions as well as the other charge modes of $\gamma N \to \pi \Delta$ are discussed and compared with experiment. (auth)

40313 BOUNDS ON ELASTIC AND INELASTIC FORM FACTORS OF THE NUCLEON AND THE PION. Cooper, Fred (Cornell Univ., Ithaca, N. Y.); Pagels, Heinz. Phys. Rev., D; 2: 228-33(1 Jul 1970).

Bounds on the nucleon form factor, the anomalous magnetic moment of nucleons, and the pion form factor are derived. By using sidewise dispersion relations and the Schwarz inequality, the elastic nucleon form factors $F_1(q^2)$ and $F_2(q^2)$ are bound by integrals over the structure functions for inelastic electron–nucleon scattering, $W_{1,2}(q^2,\nu)$. At $q^2 = 0$, unitarity is used to bound the anomalous magnetic moment by an integral over the nucleon propagator spectral function. Finally, by dispersing in q^2, the photon virtual mass, the pion form factor $F_\pi(q^2)$ is bound by an integral over the total electron–positron annihilation cross section. (auth)

40314 $\gamma\pi \to \pi\pi$ IN THE VENEZIANO MODEL AND THE LIFETIME OF THE NEUTRAL PION. Murtaza, G.; Harun-Ar-Rashid, A. M. (Univ. of Islamabad, Rawalpindi, Pakistan). Phys. Rev., D; 2: 236-8(1 Jul 1970).

The amplitude for the process $\gamma\pi \to \pi\pi$ given in terms of a five-point generalized Veneziano function is shown to remove an inconsistency in the application of the Veneziano method to the process $\pi + N \to \pi + N + \gamma$ in which the first process is known to dominate. A determination of the relevant residue function consistent with other information leads to a value of the neutral pion lifetime in good agreement with experiment, provided use is made of the idea of effective width of the ρ meson. (auth)

40315 MAGNETIC MOMENTS OF THE CHARGED OCTET BARYONS FROM LAGRANGIAN FIELD THEORY USING THE PADE APPROXIMATION. Redei, L. B. (Umea Univ., Sweden). Phys. Rev., D; 2: 239-44(1 Jul 1970).

The magnetic moments of the charged octet baryons are calculated in the lowest-order nonvanishing Padé approximation assuming pseudoscalar Yukawa coupling between the octet baryons and pseudoscalar octet mesons. The experimental value is used for the pion-nucleon coupling constant. For the other coupling constants, the SU_3 values are assumed. It is found that $\alpha = 0.725$ (α being the F/D mixing parameter, $\alpha_{expt} = 0.75 \pm 0.03$) reproduces the experimental value of the proton magnetic moment. Using this value of α, one obtains $\mu_{\Sigma^+} = 1.48$, $\mu_{\Sigma^-} = -0.31$, and $\mu_{\Xi^-} = -0.22$ for the total magnetic moments in proton magnetons. (auth)

40316 LINEARLY RISING REGGE TRAJECTORIES AND THE ISOVECTOR FORM FACTOR $F_1^V(t)$. Akcay, Hueseyin (Yale Univ., New Haven). Contract AT(30-1)-2726. Phys. Rev., D; 2: 244-7(1 Jul 1970).

A simple ansatz for the isovector Dirac form factor is examined. A fit to an approximate dipole form is achieved, and deviations from this form are also accounted for. A ρ' is no longer necessary; the next vector meson used in the saturation has a mass of approximately 1.7 GeV. The fit also gives a ρNN coupling constant which has the right value, as well as providing a good value for the nucleon charge radius. (auth)

40317 FORWARD PROTON COMPTON SCATTERING AND CONTINUOUS DISPERSION SUM RULES. Liu, Yu-chien; McGee, Ian J. (Univ. of Waterloo, Ont.). Phys. Rev., D; 2: 166-72 (1 Jul 1970).

The new invariant amplitudes of Bardeen and Tung for nucleon Compton scattering, which are free of both kinematic singularities and zeros, are examined. The forward scattering amplitude, and the continuous-dispersion sum rules derived therefrom, are obtained. Using the data of a recent calculation by Damashek and Gilman, tests of these sum rules are shown to be quite satisfactory, indicating the validity of the dispersion relation, the good parametrization of the forward proton Compton scattering amplitude, and the presence of a $J = 0$ fixed pole within the accuracy of present experiment. (auth)

40318 INELASTIC e–p SCATTERING DATA AND A NEW PARTON MODEL. Gardiner, C. W.; Majumdar, D. P. (Syracuse Univ., N. Y.). Phys. Rev., D; 2: 151-3(1 Jul 1970).

The application of the parton concepts to inelastic lepton-nucleon scattering is discussed. A series of sum rules connecting the structure function $\nu W_2(\nu, Q^2)$ and the properties of the partons is proposed. In particular, a sum rule is derived relating the structure function of the neutron and the proton which depends only on the charge distribution of the partons. An attempt is then made to generalize the quark-parton model of Bjorken and Paschos (BP) so as to fit the data on inelastic e-p scattering which are presently available. It is found that the data could not be fitted with this model. A new model is therefore developed in which the partons are not identified with quarks, and the minimum number of partons is four (whereas in the BP model it is three). It is found that this model gives an excellent fit to the data in the approximation that the scale invariance is true. It is pointed out that the minimum number of partons plays an important role in parton models. The fits also show that the mean square charge per parton is very small, which rules out any reasonable possibility of associating individual quarks with partons. (auth)

40319 RANGE OF VIRTUAL PHOTONS IN DEEP INELASTIC ep SCATTERING. Pestieau, Jean; Roy, Probir; Terazawa, Hidezumi (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 25: 402-6(10 Aug 1970).

The relative importance of the different laboratory distances of interaction of highly virtual photons is discussed in terms of the data on inelastic ep scattering in the scaling region. The definition of a characteristic distance distinguishing between short-range and long-range interactions is given. The magnitude of this quantity is extracted from the data to be about 0.65 F. (auth)

40320 PION PHOTOPRODUCTION, CONTINUOUS DISPERSION SUM RULES, AND REGGE INTERCEPTS. Liu, Yu-chien; McGee, Ian J. (Univ. of Waterloo, Ont.). Phys. Rev., D; 1: 3123-33(1 Jun 1970).

The continuous dispersion sum rules are formulated (CDSR) for pion photoproduction. Attempts are made to find the intercepts of the Regge trajectories at $t = 0$, using the result of a partial-wave analysis by Walker, and by Berends, Donnachie, and Weaver. The twelve regularized t-channel helicity amplitudes were analyzed. While reasonable results are obtained for the trajectories associated with the antisymmetric isovector [(–)] amplitudes, results for the symmetric isovector [(+)] amplitudes (in particular, the ω trajectory) are inconsistent with what we expect from hadron physics. This phenomenological analysis for $\gamma N \to \pi N$ is plagued with the additional degrees of freedom allowed by the electromagnetic nature of the reaction. It is also possible that the cutoff energy used in the CDSR is not high enough. Further investigation in the analysis of the data is necessary. In connection with the study of the helicity amplitudes for pion photoproduction, by eliminating the invariant amplitudes, the crossing relation between the s- and t-channel amplitudes are obtained without recourse to the crossing matrix. (auth)

40321 PROTON POLARIZATION IN ELASTIC ELECTRON–PROTON SCATTERING. Arafune, J.; Shimizu, Y. (Tokyo Univ.). Phys. Rev., D; 1: 3094-7(1 Jun 1970).

The proton polarization in elastic electron-proton scattering is calculated. In order to calculate the imaginary part of the scattering amplitude, unitarity is used taking only the electron-proton state as the intermediate state. The maximum magnitude of the polarization for energies near about 1 GeV/c is ~0.2%. The energy value at which the polarization vanishes independently of scattering angles is found. (auth)

40322 WHEN WILL ELECTROPRODUCTION AND PHOTOPRODUCTION SHOW DIFFRACTIVE FEATURES. Nieh, H. T. (State Univ. of New York, Stony Brook). Phys. Rev., D; 1: 3161-4(1 Jun 1970).

A simple interpretation is given to the diffraction model for electroproduction and photoproduction. Conjectures are also made regarding the region of validity for Sakurai's results on electroproduction. (auth)

40323 GENERALIZED VECTOR DOMINANCE THEORY AND VERTEX FUNCTIONS. Frampton, P. H. (Univ. of Chicago). Phys. Rev., D; 1: 3141-51(1 Jun 1970).

A simple model formula for the hadronic form factors as a ratio of two Γ functions is examined from the point of view of its consistency with the beta-function model and with the chiral properties of the vector and axial-vector currents. It is shown that similar models may hold simultaneously for the simplest vector and axial-vector form factors while maintaining consistency with the Veneziano model of the four-point function, and with the requirements of a conserved vector current, partially conserved axial-vector current, and the Gell–Mann algebra of currents. An infinite class of such solutions is found: Defining form factors by $\langle \pi^+(p_2)|V_\mu^0(0)|\pi^+(p_1)\rangle = F_V(t)(p_1 + p_2)_\mu$ and $\langle \sigma(p_2)|A_\mu^0(0)|\pi^0(p_1)\rangle = F_A^+(t)(p_1 + p_2)_\mu + F_A^-(t)(p_1 - p_2)_\mu$, where $t = (p_1 - p_2)^2$, the solutions $F_V(t) \propto \Gamma[1 - \alpha_V(t)]/\Gamma[r_V + 1 - \alpha_V(t)]$ and $F_A^+(t) \propto \Gamma[1 - \alpha_A(t)]/\Gamma[r_A + 1 - \alpha_A(t)]$ are found, where $\alpha_V(t)$ is the ρ Regge trajectory and $\alpha_A(t)$ is the π-A_1 Regge trajectory. The power behaviors of

$F_A(t)$ and $F_V(t)$ for $|t| \to \infty$ are not determined absolutely, but the relative power is found to be $r_V - r_A = \frac{1}{2}$, as a consequence of a quantization rule for the trajectory intercepts. Scalar and pseudoscalar form factors are treated also, with similar results; in the approximation used here, however, it is required that the pseudoscalar form factor $P(t)$ in $\langle \pi(p_2)|\partial_\mu A_\mu^3(0)|\pi^0(p_1)\rangle = M_\pi^2 P(t)$ be dominated by the ground-state pion alone, that is, $P(t) \propto \Gamma[-\alpha_A(t)]/\Gamma[1-\alpha_A(t)]$, in order to ensure absence of non-gauge-invariant terms in the matrix element $\langle \pi^+(p_2)|V_\mu^3(0)|\pi^+(p_1)\rangle$. In order to consider matrix elements of the vector- and axial-vector-current operators between other hadron states, generalized field-current identities are written, using the forms of $F_V(t)$ and $F_A^\pi(t)$, and a universality hypothesis is made that the vector mesons ρ and A_1 and their higher recurrences couple universally to the independent helicity amplitudes of the Breit frame. As an example, a treatment of the nucleon electromagnetic and axial-vector form factors is given, leading to simple model formulas for the Sachs form factors $G_E(t)$ and $G_M(t)$, and the axial-vector form factor $G_A(t)$, which for spacelike values of t agree well with the experimental results. (auth)

40324 $\gamma - 3\pi$ COUPLING CONSTANT IN THE VENEZIANO MODEL. Sundaram, A. (Inst. of Mathematical Sciences, Madras). Prog. Theor. Phys. (Kyoto); 43: 843-4(Mar 1970).

The $\gamma - 3\pi$ coupling constant is calculated using vector dominance and the Veneziano model. The result $\Lambda = 0.12$ was found in agreement with the value obtained from photoproduction data. (L.B.S.)

40325 KINEMATICAL STRUCTURE OF THE VECTOR DOMINANCE MODEL IN PHOTO-REACTION. Ebata, Takeshi (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 43: 709-20(Mar 1970).

The kinematical structure of the photo-reaction amplitude is studied for the case of a simple model. It is shown that the amplitude for the corresponding vector meson production amplitude can be constructed in such a way as to ensure the vector-meson-photon coupling based on the vector dominance model kinematically. The "gauge condition" for the massive vector meson implies a relation between the helicity amplitudes, and this can be parametrized when the partial wave expansion is made. The examples based on perturbation and Regge-pole theories show that the formulation is consistent with the theory at all energies. It is shown that under a certain condition the experimentally tested "vector-dominance-model" relation between photoproduction amplitudes and the corresponding vector-meson production amplitudes can hold to a good approximation. (auth)

40326 DEEP SEA SEARCH FOR MULTIPLY-CHARGED MAGNETIC POLES. Fleischer, R. L. (General Electric Research and Development Center, Schenectady, N. Y.); Hart, H. R. Jr.; Jacobs, I. S.; Price, P. B.; Schwarz, W. M.; Goodell, H. G.; Aumento, F. Radiat. Eff.; 3: 137-8(May 1970).

A summary of two searches for magnetic monopoles is presented. Limits are set on the possible abundance of the monopoles; and the possible extra-galactic origin of the highest existing cosmic rays is considered. High-field magnets are used to attempt to extract monopoles from ferromanganese deposits dredged out of the deep ocean. (J.F.P.)

Weak

40327 (NYO-2171-316) $\eta - \pi^0$ MIXING IN $K^+ \to \pi^+\pi^0$ DECAY. Goyal, Ashok; Li, Ling-Fong; Segre, Gino (Pennsylvania Univ., Philadelphia. Dept. of Physics). [1970]. 7p. Dep. CFSTI.

The effect of a possible virtual $\eta \to \pi^0$ transition on the $K^+ \to \pi^+\pi^0$ decay using the general U-spin consideration and also by allowing the transition to be induced by a nonelectromagnetic isospin violating term in the Hamiltonian is discussed. (auth)

40328 S-MATRIX MODELS FOR WEAK INTERACTIONS. Barut, A. O.; Nagylaki, T. (Univ. of Colorado, Boulder). Lett. Nuovo Cim.; 4: 161-3(25 Jul 1970).

The S-matrix formulation for weak interactions is discussed for the process $e + \nu \to e + \nu$. The case when only a right-hand cut is present in the amplitude is studied. It is shown that elastic unitarity with a right-hand cut only (the Zachariasen model for the problem) implies that there is no scattering. An inelasticity factor is then introduced. It is found that a meaningful and tractable S-matrix model for weak processes is yet to be formulated. (J.F.P.)

40329 $K \to 3\pi$ DECAYS IN DUAL MODELS. Hara, Yasuo. (Univ. of Maryland, College Park). Phys. Rev., D; 2: 376-86 (15 Jul 1970).

The dual representation of $K \to 3\pi$ decay amplitudes is studied. It is found that $K \to 3\pi$ decay amplitudes in a generalized Veneziano model are incompatible with current-algebra relations. For example, pion poles and kaon poles are not dual to other poles. An example of realistic $K \to 3\pi$ decay amplitudes which contain pion and kaon poles, which contain both $|\Delta I| = \frac{1}{2}$ and $\frac{3}{2}$ parts, and which are compatible with current-algebra relations is obtained. The results seem to suggest that the charged-current × charged-current nonleptonic weak Hamiltonian should be preferred to Hamiltonians with pure $|\Delta I| = \frac{1}{2}$. (auth)

40330 WEAK NEUTRAL CURRENTS IN ASTROPHYSICS. Desrosiers, L.; O'Donnell, P. J. (Univ. of Toronto). Phys. Rev., D; 2: 403-4(15 Jul 1970).

The effect of weak neutral currents in astrophysics is studied. A major effect is to reduce the effective $e\nu$ coupling by one-half. A new (minor) source of neutrino emission is shown to exist to first order in the weak and electromagnetic coupling. (auth)

40331 REGGE EFFECTS IN WEAK AMPLITUDES. Risk, Clifford (Univ. of California, Berkeley). Phys. Rev., D; 2: 387-91(15 Jul 1970).

Recently Regge effects have been studied in weak amplitudes by describing the final-state strong interaction with a Regge pole at $J = \phi(t)$. In particular, it has been shown that the double-helicity-flip amplitude $A_1(s,t)$ for the process $\gamma\pi \to \gamma\pi$ has a moving pole at $J = \phi(t) = 2$ and a fixed pole at $J = -1$, and that the electromagnetic form factor of the pion $F_\pi(s)$, can be written as $F_\pi(s) = 1 + G_\rho(s) + G_\rho(s)$, where $G_\rho(s) \to s^{\phi(0)-1}[1 + 0(1/\ln s)]$. It is demonstrated how these results can be obtained by a simple and direct method that draws out an immediate physical understanding of the results obtained. The method involves the study of the asymptotic behavior of the relevant field-theoretic diagrams with the use of Sudakov variables. (auth)

40332 NEUTRINO BREMSSTRAHLUNG IN AN INTENSE MAGNETIC FIELD. Canuto, V.; Chiu, H. Y.; Chou, C. K. (Goddard Space Flight Center, New York). Phys. Rev., D; 2: 281-7(15 Jul 1970).

The neutrino luminosity due to a completely relativistic electron gas in the presence of an intense magnetic field is studied. The neutrino emission rate is determined rigorously, under the assumption of the V – A theory of universal weak Fermi interaction, by standard field-theoretical methods. It is shown that the neutrino radiation rate can be expressed as a function of temperature, density, and the field-strength parameter $\Theta = H/H_c$, where $H_c = m^2c^3/e\hbar = 4.414 \times 10^{13}$G. Comparisons are made with previous approximate results due to others, and the reasons for discrepancies are discussed. (auth)

40333 NEUTRINOS VERSUS MUONS IN W-BOSON PRODUCTION. Brown, R. W. (Brookhaven National Lab., Upton, N. Y.); Mann, A. K.; Smith, J. Phys. Rev. Lett.; 25: 257-60(27 Jul 1970).

Detailed calculations show that the theoretical total cross section for the production of the intermediate vector boson W by incident neutrinos is much larger than that for W production by incident muons in the relevant range of National Accelerator Laboratory energies and corresponding W masses. (auth)

40334 B-MESON AND T-VIOLATION IN RADIATIVE π DECAY. Holstein, B. R. (Princeton Univ., N. J.). Nuovo Cim.; 68A: 369-82(1 Aug 1970).

It is shown that Kim and Primakoff's suggestion that second-class axial vector currents are present in the semi-leptonic weak Hamiltonian leads to T-violating effects in $\pi^+ \to l^+\nu_l\gamma$. Using Maiani's model for these currents and dominating them by the B-meson, the size of possible T-violating effects is estimated. Theoretical predictions are compared with current experimental evidence. (auth)

40335 UNITARITY AND THE PHASE OF THE MIXING PARAMETER IN SUPERWEAK THEORIES. Kenny, B. G. (Australian National Univ., Canberra); Kabir, P. K. Phys. Rev., D; 2: 257-8(1 Jul 1970).

The Bell–Steinberger unitarity condition is used to discuss the relation between the phase ϕ_W of the "unitarity sum" appearing in that relation and the Lee–Wolfenstein phase ϕ_t, for which an explicit formula is given in terms of $|\epsilon|$, γ_1, γ_2, and $m_2 - m_1$. (auth)

40336 NEUTRAL KAON DECAYS INTO LEPTON PAIRS. Martin, B. R. (University Coll., London); de Rafael, E.; Smith, J. Contract AT(30-1)-3668B. Phys. Rev., D; 2: 179-200(1 Jul 1970).

The decay modes $K_1^0 \to \mu^+\mu^-$ and $K_2^0 \to \mu^+\mu^-$ are discussed within the framework of first-order weak combined with fourth-order electromagnetic interactions. The possibility of obtaining lower bounds to the corresponding decay rates is examined, and estimates of the lower bounds are given in a perturbation-theory

model. Possible enhancement effects due to strong interactions have been estimated through a simple model of final-state interactions. The assumption of CP invariance is made throughout. (auth)

40337 CURRENT COMMUTATORS, DISPERSION RELATIONS, AND K_{l3} FORM FACTORS. Radescu, E. E. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., D; 2: 142-50(1 Jul 1970).

A treatment of K_{l3} decays is presented based on current commutators and using a covariant sum-rule formulation. Working in a general kinematical configuration and dispersing on a line (in the plane of the squared pion mass and of the momentum transfer) which belongs to a family of curves all parallel to the "steepest" (kaon rest frame) parabola, definite expressions are written for the form factors f_+ and f_-. The relation of our procedure to other recently reported approaches is discussed. (auth)

40338 FERMION SCATTERING IN THE CHAIN APPROXIMATION TO V–A THEORY OF WEAK INTERACTIONS. Masleev, N. N.; Tikhonin, F. F. (Kazakh State Univ., Alma-Ata, USSR. Inst. of High-Energy Physics, Serpukhov, USSR). Teor. Mat. Fiz.; 4: 33-7(Jul 1970). (In Russian).

The fermion scattering cross section was evaluated by means of Bethe–Salpeter equation for the four-fermion interaction in the chain approximation. The cross section obtained increases with energy up to a certain value only and then it decreases rapidly, unlike the behavior of the cross section as given by the first order of perturbation theory. (auth)

40339 W-BOSON PRODUCTION IN $\nu_\mu + p \rightarrow \mu + W + \Gamma$. Chen, Herbert H. (Univ. of California, Irvine). Phys. Rev., D; 1: 3197-9(1 Jun 1970).

The cross section for the production of the (hypothetical) intermediate vector boson of weak interactions (W boson) in the reaction $\nu_\mu + p \rightarrow \mu + W + \Gamma$, where Γ is a hadronic state unassociated with nucleon resonances, is calculated. The input to the numerical calculation is derived from analyzed results of the recent SLAC deep-inelastic e-p scattering experiment. Owing to the mild momentum-transfer dependence of the observed $\gamma p\Gamma$ vertex, the resulting W-boson production cross section is found to be important only near threshold and to contribute a non-negligible amount to the total production cross section if the ratio of W-boson mass to nucleon mass is much larger than 1. (auth)

40340 DECAYS $K \rightarrow 2\pi$ IN THE QUARK MODEL. Smith, C. H. Llewellyn (CERN, Geneva). Phys. Rev., D; 1: 3194-5 (1 Jun 1970).

It is shown that simple quark models with a current-current interaction do not lead to the results of the $\Delta I = \frac{1}{2}$ rule. Previous calculations giving these results effectively treat quarks as bosons. (auth)

40341 HIGH-ENERGY INELASTIC NEUTRINO–NUCLEON INTERACTIONS. Bjorken, J. D.; Paschos, E. A. (Stanford Univ., Calif.). Phys. Rev., D; 1: 3151-60(1 Jun 1970).

High-energy inelastic neutrino-nucleon processes are discussed in the light of recent theoretical and experimental developments for the corresponding electroproduction processes. The kinematics for the process are reviewed in a form especially convenient for experimental analysis. Sum rules and results related to current commutation relations are discussed. Consequences of the parton model and diffractive models are considered. Other results are: (1) The vector and axial-vector contributions to the total cross section are equal, provided the only symmetry-breaking term in the energy density transforms like a quark-mass term under $U(6) \oplus U(6)$. (2) Scale invariance of one of the three form factors ($\nu\beta$ or νW_3) describing the process implies a neutrino total cross section which rises linearly with laboratory energy, provided the lepton current is local and there is no W boson. The effect of a W boson on this result is studied. (3) The relation of existing neutrino data and electroproduction data given by the conserved-vector-current hypothesis is studied and found compatible with experiment. (auth)

40342 SUM RULE FOR THE VECTOR-AXIAL-VECTOR INTERFERENCE FORM FACTOR IN INELASTIC NEUTRINO–NUCLEON SCATTERING. Paschos, E. A. (Rockefeller Univ., New York). Phys. Rev., D; 1: 3138-40(1 Jun 1970).

The assumptions frequently made in current algebra together with Regge asymptotic behavior give a sum rule for $W_3^{\bar{p}}(Q^2 \approx 0, \nu) + W_3^{\bar{n}}Q^2 \approx 0, \nu)$ that involves only physically observable quantities. (auth)

40343 UNIVERSALITY OF DEEP INELASTIC LEPTON–HADRON SCATTERING. Mack, G. (Univ. of Miami, Coral Gables, Fla.). Phys. Rev. Lett.; 25: 400-01(10 Aug 1970).

In Wilson's theory of scale invariance at short distances, the Callan–Gross integral for electroproduction comes out to depend on the target hadron only through a factor of target mass. Experimental tests of this result, or of related results by Gatto and collaborators, will have a bearing on the theoretical question of anomalous dimensions of length. (auth)

40344 SIMPLE RELATION BETWEEN CROSS SECTIONS FOR NEUTRINO SCATTERING AND TOTAL MUON-CAPTURE RATES BY NUCLEI. Frazier, John (Johns Hopkins Univ., Baltimore); Kim, C. W.; Ram, Michael. Phys. Rev., D; 1: 3168-71(1 Jun 1970).

Using the closure approximation, a simple relation between the total forward cross section for elastic scattering of neutrinos by nuclei and the corresponding total muon-capture rates is obtained. This relation is in good agreement with previous estimates of neutrino scattering cross sections, but still in disagreement with recent experimental data. (auth)

40345 ON-SHELL CURRENT ALGEBRA AND THE RADIATIVE LEPTONIC DECAY OF K^+. Carron, N. J.; Schult, R. L. (Univ. of Illinois, Urbana). Phys. Rev., D; 1: 3171-9(1 Jun 1970).

Dispersion relations and the hard-meson method of Schnitzer and Weinberg are used to study the radiative leptonic decay of the K^+. It is shown that in the pole-dominance approximation the relevant form factor in the axial-vector amplitude cannot be unsubtracted. Possible alterations of the results arising from relaxing a smoothness approximation are estimated to be small. Various symmetry-breaking schemes for the evaluation of necessary coupling constants are discussed and compared. The branching ratio for $K^+ \rightarrow \gamma e^+ \nu$ is calculated to be $\sim 2.5 \times 10^{-5}$ for interesting structure-dependent decays. This is comparable to that for $K \rightarrow e\nu$ and two orders of magnitude larger than one would expect from the usual estimates for electromagnetic decays. The feasibility of experimentally observing the decay is discussed, as are the possible effects of electromagnetic violations of time-reversal invariance. From these results, a soft-pion estimate of F_4, the vector form factor in K_{l4}, yields $|F_4| \approx 6.9$. (auth)

40346 THEORETICAL CROSS SECTION OF INTERMEDIATE-BOSON PRODUCTION FROM NEUTRINOS. Wu, Alfred C. T. (Univ. of Michigan, Ann Arbor); Yang, Chen-ping. Phys. Rev., D; 1: 3180-4(1 Jun 1970).

With the availability of higher accelerator energies in the foreseeable future, it is to be expected that renewed efforts will be made to search for the hypothetical intermediate bosons in the next generation of neutrino experiments. Some details of the theoretical calculation of the production cross section upon which the numerical computation is based are given. The differential cross section is computed in closed form. The calculation of the total cross section is reduced to a two-dimensional integral to be evaluated numerically. (auth)

40347 PARITY-CONSERVING NONLEPTONIC DECAYS OF HYPERONS AND THE SU(3)-SYMMETRY BREAKING OF THE STRONG INTERACTION. COMMENT ON $\bar{B}_8 B_8 \Pi_8$ VERTEX SIMILARITY. Murayama, Akihiro; Fujji, Kanji; Hirano Masanobu (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto); 43: 789-98(Mar 1970).

Implications of the similarity between the vertices $\bar{B}_8 B_8 \Pi_8$ of the SU(3)-breaking strong coupling and the parity-conserving nonleptonic hyperon decays are investigated. It is noted that, where the structure of the strong vertices is determined so as to be consistent with the P-wave decay amplitudes of hyperons, three or more strong-coupling constants can be relatively SU(3)-symmetric if the 'renormalized' F/D-ratio is properly redefined. Dependence of the strong-coupling constants and the 'renormalized' F/D-ratio on the SU(3)-breaking parameter is presented by setting the 'bare' F/D ratio to be 2/3. (auth)

40348 BOSE QUARKS AND NON-LEPTONIC WEAK INTERACTIONS. Goto, Tetsuo; Hara, Osamu; Ishida, Shin (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 43: 849-51(Mar 1970).

It is shown that the assumption that quarks obey Bose statistics leads to a satisfactory understanding of the nonleptonic weak interactions. (L.B.S.)

40349 K_{l3}-DECAY AND SCALAR COUPLING IN THE WEAK INTERACTIONS OF URBARYONS Kaneko, Takao (Meijo Univ., Nagoya, Japan). Progr. Theor. Phys. (Kyoto); 43: 856-7(Mar 1970).

The magnitude of the scalar coupling which might exist in the weak interactions of urbaryons is discussed using recent experimental data on the parameter ξ in K_{l3} decays. (L.B.S.)

Strong (General)

40350 (JINR-P1-5123) IDENTIFICATION OF THE REACTIONS AT HIGH ENERGIES. Dumbrais, O. V.; Kopylov, G. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1970. 13p. (In Russian). Dep. CFSTI (U. S. Sales Only).

At energies in the range of a few tens of GeV where the usual methods of identification of reactions fail, the introduction of a functional permitting tests of the hypothesis of resonance production makes it possible to distinguish the groups of reactions where resonances are produced from those without resonance production. An attempt to separate different reactions with the production of resonances fails. (auth)

40351 (NYO-2171-315) CURRENT COMMUTATOR DERIVATION OF MASS DIFFERENCE RELATIONS. Goyal, Ashok; Li, Ling Fong; Segre, Gino (Pennsylvania Univ., Philadelphia. Dept. of Physics). [1970]. 21p. Dep. CFSTI.

The consequences of the vanishing of certain double commutators are investigated to examine the consistency of SU(3) × SU(3) breaking models. Also the contribution of $\Delta I = 2$ mass differences of isospin violating terms other than the electromagnetic interactions, in the Hamiltonian are calculated. (auth)

40352 SPECTRUM OF HADRONS. Lipkin, H. J. (Weizmann Inst. of Science, Rehovot, Israel). Riv. Nuovo Cim.; 1: Special No., 134-54(1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

A general review of hadron spectroscopy is presented. The similarities and differences with atomic and nuclear spectroscopy are pointed out. The principle qualitative features of the experimental data that give information about the properties of the hadron spectrum are outlined. The remaining discussions deal with exotic resonances, quarks, and triality; exotic states, flat cross sections and duality; and quark model spectroscopy. (L.B.S.)

40353 REVIEW OF THE PRESENT EVIDENCE FOR MULTI-REGGE POLE PROCESSES. Ranft, Gisela (University Coll., London). Fortschr. Phys.; 18: No. 1, 1-41(1970).

The present understanding of particle production processes in terms of the multi-Regge pole exchange model is reviewed from the theoretical and phenomenological point of view. It is concluded that the model discussed up to the present represents many different features of the data. Further tests of the model are discussed. (auth)

40354 MODIFIED POMERANCHUK THEOREM AND SERPUKHOV DATA. Saleem, M. (Univ. of Panjab, Lahore). Lett. Nuovo Cim.; 3: 744-8(13 Jun 1970).

It is shown that a modification of the assumption that the real part of the forward scattering amplitude is not too large as compared with the imaginary part, leads to a new form of the Pomeranchuk theorem which is consistent with the Serpukhov data. Also differential cross sections for various $\pi + p$ interactions are found combining the invariance of asymptotic spin with the modified Pomeranchuk theorem. (J.F.P.)

40355 DUAL CONSERVED CURRENT AND LOCAL FIELD INTERPRETATION OF THE MULTIPARTICLE VENEZIANO AMPLITUDE. Bouchiat, C.; Gervais, J. L.; Sourlas, N. (Faculte des Sciences, Orsay, France). Lett. Nuovo Cim.; 3: 767-75(13 Jun 1970).

It is shown that it is possible to construct a conserved current from the multiparticle dual amplitude. The construction is such that the current will satisfy duality and the factorization properties of the hadronic amplitudes. This current is free from kinematical singularity in the momentum transfer. (J.F.P.)

40356 DIPS AT NONSENSE WRONG-SIGNATURE POINTS. Bander, Myron; Gotsman, E. (Univ. of California, Irvine). Phys. Rev., D; 2: 224-7(1 Jul 1970).

A model for residues of odd- and even-signature trajectories is presented which successfully accounts for the presence of dips in the differential cross sections of two-body reactions near the forward directions. (auth)

40357 QUARKS WITH COMPLEX SPIN. Roginskii, V. I.; Shapiro, I. S. Teor. Mat. Fiz.; 4: 38-47(Jul 1970). (In Russian).

Previously the foundations of quantum kinematics of a system of two "particles" with complex spins differing from each other by an integer or half odd integer number were formulated. It is shown that it is possible to construct dynamics of such a system: to introduce the Hilbert space of states and the Hamiltonian and take account of the identity of "particles." A compound model in which elementary particles are thought to consist of two unobservable complex spin "quarks" (the case of spin-$\frac{1}{2}$ is considered) is discussed. It is shown that in this model the mass spectrum and properties of particles (for instance, the multipole and magnetic momenta) can prove essentially different than in the conventional compound model (when quark spin is integer or half odd integer). (auth)

40358 RULES FOR CONSTRUCTING DUAL AMPLITUDES. Gross, David J.; Schwarz, John H. (Princeton Univ., N. J.). Phys. Rev. Lett.; 25: 406-9(10 Aug 1970).

The projected propagator of the dual-resonance model is presented. It is used to give an operator proof of duality and to construct various tree and loop operators. (auth)

40359 ANOMALOUS REAL PARTS IN THE T MATRICES OF UNSTABLE PARTICLES. Bauer, Theodore (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 25: 485-8(17 Aug 1970).

Anomalous, possibly large real parts in the T matrices for high-energy scattering of unstable particles are shown to be a dynamical consequence of instability. This effect is estimated to be quite large in the case of the photoproduction and elastic scattering of ρ^0 mesons from nucleons and can be interpreted as a breakdown of the simple "ρ^0-photon analogy." (auth)

40360 TWO-FIREBALL PHENOMENON AND THE MULTIPERIPHERAL MODEL. DeTar, Carleton E.; Snider, Dale R. (Univ. of California, Berkeley). Phys. Rev. Lett.; 25: 410-13 (10 Aug 1970).

In the context of the Chew-Snider version of the Amati-Bertocchi-Fubini-Stanghellini-Tonin pion-exchange model, certain multiperipheral mechanisms that could account for those phenomena that have hitherto motivated the two-fireball model are investigated. These mechanisms are (1) double diffractive dissociation, (2) the presence of a sequence of neutral particles on the multiperipheral chain, and (3) statistical fluctuations in the log tanθ spectrum. At cosmic-ray energies they are of equal importance. (auth)

40361 STRUCTURE OF REPRESENTATION OF THE ALGEBRA OF CURRENT DENSITIES. Sankaranarayanan, A. (Douglas Advanced Research Labs., Huntington Beach, Calif. California State Coll., Long Beach). Progr. Theor. Phys. (Kyoto); 43: 845-7(Mar 1970).

An attempt is made to demonstrate the underlying group theoretical structure of the algebraic system composed of the vector and axial-vector current densities, angular momentum operator, mass operator, and parity operator given for a single quark with an infinite number of excited states and degenerate mass. (L.B.S.)

40362 INFINITE-COMPONENT WAVE EQUATION AND FAMILIES OF LINEAR TRAJECTORIES. Morita, Katsusada (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 43: 847-9 (Mar 1970).

An infinite-component wave equation is presented that leads to four families of linearly ascending and parallel trajectories. The internal structure of particles on the trajectories is visualized as composed of quasi-constituents bound by a Coulomb potential. A modified equation is also presented that splits the trajectories by the rule $\Delta J = 1/2$. (L.B.S.)

Strong (Baryon No. = 0)

Refer also to abstract 40356.

40363 (COO-1428-174) ROTATION INVARIANCE AND THE STRUCTURE OF THE S-WAVE $\pi\pi$ CROSS SECTION. Gutay, L. J.; Scharenguivel, J. H.; Fuchs, N.; Gaidos, J.; Miller, D. H.; Meiere, F. F.; Harms, B. (Purdue Univ., Lafayette, Ind.) Feb 1970. 15p. Dep. CFSTI.

The isotropic term measured in the $\pi\pi$ angular distribution in pion production contains two components. One component is invariant, the other transforms like a second rank tensor under space rotation. The $\pi\pi$ effective mass distribution was determined for the isotropic term in a coordinate system where the tensor component is minimized. A new structure at 0.66 GeV was observed. (auth)

40364 NO-GO THEOREM FOR DUALITY AND BARYON-ANTIBARYON SCATTERING. Lipkin, H. J. (Weizmann Inst. of Science, Rehovot, Israel). Contract F-61052-68-C-0070. Phys. Lett.; 32B: 301-2(6 Jul 1970).

Global duality and absence of exotics are shown to be sufficient to require decoupling of leading isovector trajectories from $A\bar{A}$ scattering and from all charge exchange $B\bar{B}$ reactions with exotic s-channel quantum numbers. Breaking duality or modifying Pomeranchuk conjectures does not avoid the difficulty. Either

appreciable exotic contributions are present in the FESR or the leading trajectories are decoupled from all processes involving decuplet baryons. (auth)

40365 VENEZIANO-LIKE PION FORM FACTOR AND HARD-PION CURRENT ALGEBRA. Acharya, R.; Brink, L.; Saxena, R. P. (Inst. of Theoretical Physics, Goteborg). Lett. Nuovo Cim.; 4: 153-6(25 Jul 1970).

Some models are tested with reference to the $\pi^+ - \pi^0$ mass difference problem and the unitarity condition for the pion form factor obtained using hard-pion current algebra. (J.F.P.)

40366 ASYMPTOTIC BEHAVIOR OF THE UNITARIZED $\pi-\pi$ VENEZIANO AMPLITUDE. Muta, T.; Nakajima, H.; Niegawa, A. (Kyoto Univ.). Lett. Nuovo Cim.; 4: 167-71(25 Jul 1970).

The conjecture is examined that the Pomeranchuk behavior of elastic scattering amplitudes of hadrons may be obtained by considering nonplanar loop amplitudes which are equivalent in the quark diagram to other diagrams. This conjecture is examined in the s-channel unitarity relation with the help of the $\pi + \pi$ Veneziano amplitude. The conclusion is that as far as elastic unitarity is concerned one can at most generate the Regge-cut contribution in this scheme. (J.F.P.)

40367 VENEZIANO-LIKE MODEL FOR THE ISOSCALAR-CURRENT THREE-PION AMPLITUDE. Cooper, Fred (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 2: 361-3(15 Jul 1970).

Using mutilated five-point functions, an amplitude for $S^\mu + \pi \to \pi\pi$ is constructed where S^μ is an isoscalar current. The amplitude satisfies crossing symmetry and the Adler condition, and contains an infinite sequence of poles in the current momentum squared. We find that it reduces to the Veneziano amplitude on the ω mass shell. For fixed q^2 and t, as $s \to \infty$ the amplitude behaves as $\Gamma(1 - \alpha(t))B(1 - \alpha(q^2), \alpha_\rho(t) - \gamma_1)s^{\alpha(t)}$. It is found by normalizing the amplitude that $\gamma_1 = -1$, and thus the amplitude has fixed multiplicative poles at $\alpha_\rho(t) = -1, -2, \ldots$, except at an ω daughter pole. This model is then compared with vector dominance. (auth)

40368 ASYMPTOTIC SYMMETRY, CURRENT ALGEBRA, AND THE VENEZIANO ANSATZ. Acharya, R. (Univ., Bern. Chalmers Univ. of Tech., Goteborg). Phys. Rev., D; 2: 399-402(15 Jul 1970).

The universality of the slopes of meson trajectories is established in the context of the Veneziano model from the postulate of asymptotic SU(3) × SU(3) symmetry and without reference to the Adler consistency conditions. (auth)

40369 VENEZIANO-LIKE MODEL FOR THE AXIAL-VECTOR-CURRENT THREE-PION AMPLITUDE. Cooper, Fred (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 2: 391-3(15 Jul 1970).

The general features of non-vector-dominance Veneziano models for $A^\mu\pi \to \pi\pi$ are explored. It is assumed that the axial-vector current is conserved (zero-mass pions) and the invariant amplitudes are written as products of beta functions and arbitrary functions of the axial-vector-current momentum squared. By using a soft-pion theorem, statements about the pion form factor are obtained. In a particular model of the above type (the spurion model applied to the five-point function) it is found that $F(q^2) = \pi^{-1}\Gamma(\frac{1}{2})\Gamma(-q^2 + \frac{1}{2})\Gamma(-\gamma_2 + \frac{1}{2})/\Gamma(-q^2 - \gamma_2 + \frac{1}{2})$. (auth)

40370 $\pi\pi$ PHASE SHIFTS AT LOW ENERGY DETERMINED FROM THE PERIPHERAL MODEL. Fulco, Jose R. (Univ. of California, Santa Barbara); Shaw, Gordon L. Symp. Theor. Phys. Math.; 10: 101-14(1970).

From Symposia on Theoretical Physics and Mathematics, Madras, India. See CONF-690125.

A critical analysis of the use of the peripheral model with absorptive corrections for extracting data about $\pi + \pi$ scattering from one pion production processes in pion-nucleon collisions is made. Pion production via one-pion exchange, the absorption model for calculation of the $\pi\pi$ spin density production matrix elements, and determination of the $\pi\pi$ phase shifts are discussed. (J.F.P.)

40371 FURTHER EXAMINATION OF LOW-MASS $\bar{p}\pi^-\pi^+$ AND $p\pi^-\pi^+$ ENHANCEMENTS IN THE REACTION $\bar{p}p \to \bar{p}\pi^-p\pi^+$ AT 2.8 to 3.5 GeV/c. Bomse, F.; Moses, E. J.; Borak, T. B. (Vanderbilt Univ., Nashville). Nuovo Cim.; 68A: 383-9(1 Aug 1970).

It is shown that an enhancement at 1.4 GeV in the $\bar{p}\pi^-\pi^+$ and $p\pi^-\pi^+$ mass spectra from the reaction $\bar{p}p \to \bar{p}p\pi^+\pi^-$ at 2.8 to 3.5 GeV/c is not a reflection of the process $\bar{p}p \to \bar{N}^*(1238)N^*(1238)$. (auth)

40372 BOOTSTRAP OF THE ρ TRAJECTORY. Shan, Y. (Florida State Univ., Tallahassee). Nuovo Cim.; 68A: 390-6 (1 Aug 1970).

The reaction $\omega + \pi \to \pi + \pi$ is considered in a bootstrap calculation of the ρ trajectory. It is found that at each fixed value of t, there exists a unique solution. The calculated values of both the slope and the intercept are in reasonable agreement with those obtained from π^-p charge-exchange experiments. (auth)

40373 RELATIVISTIC QUARK FIELD THEORY USING THE PADE METHOD. Nitti, L. (Univ., Bari. Istituto Nazionale di Fisica Nucleare, Bari); Pusterla, M. Lett. Nuovo Cim.; 3: 757-61(13 Jun 1970).

Within a previous scheme for extracting quantitative information from a field-theoretical model in strong-coupling physics by introducing the Pade approximant method of the renormalized S-matrix, a relativistic field-theoretic model for quarks is considered. It is investigated whether the mesons may appear as bound states of the quark-antiquark system with a previously described relativistic interaction. As a consequence the physical mesonic mass spectrum may be reproduced in terms of the parameters of this model using the Pade approximants of the renormalized S-matrix. (J.F.P.)

40374 LINEAR AND NONLINEAR REALIZATIONS OF SU_2 X SU_2 AND THE A_1 DECAY. Mazzanti, P.; Salvini, M. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna). Lett. Nuovo Cim.; 4: 19-25(4 Jul 1970).

The A_1 decay in the framework of chiral effective Lagrangians is discussed. It is assumed that the vector and axial vector fields and the pion and sigma fields are placed respectively in the (1,0) + (0,1) and $(\frac{1}{2},\frac{1}{2})$ representations of the SU(2) × SU(2) group. (J.F.P.)

40375 NONPARALLEL DAUGHTERS AND pi-pi SCATTERING. Copley, L. A.; Eilbeck, J. C. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 4: 7-12 (4 Jul 1970).

It is shown that nonparallel daughter trajectories can give a theory for $\pi + \pi$ interactions which avoids the previous difficulties of making the models unitary and removing parity doublets. This theory compares with experiment and low-energy constraints as adequately as previous models. (J.F.P.)

40376 NOTE ON INELASTIC RESONANCES IN F_π. Walsh, T. F. (Univ. of Minnesota, Minneapolis). Nuovo Cim., 68A: 469-76(1 Aug 1970).

The following questions are briefly considered: if higher-mass vector mesons exist, how would they affect the peak of the pion form factor at the rho mass, $|F_\pi(M_\rho^2)|^2$, and how prominent should they be in the cross section for, e.g., $\rho^+\rho^- \to \pi^+\pi^-$ at the resonance mass. The questions are strongly related, and if certain physically reasonable zeros occur in the form factor the effect of such mesons can turn out to be quite small. (auth)

40377 PREDICTIONS OF THE AMATI-BERTOCCHI-FUBINI-STANGHELLINI-TONIN MULTIPERIPHERAL MODEL. Tow, Don M. (Univ. of California, Berkeley). Phys. Rev., D; 2: 154-63(1 Jul 1970).

The predictions of the Amati-Bertocchi-Fubini-Stanghellini-Tonin multiperipheral model based on pion pole dominance are calculated quantitatively and compared with experimental data, by using the Veneziano representation for the $\pi-\pi$ amplitude, with a cutoff at the mass of the g resonance for the input kernel, and neglecting off-shell effects. The results yielded $\alpha_\rho(0) = 0.30$, $\alpha_\rho(0) = 0.16$, an average multiplicity growing as 0.74 ln s, an elasticity factor of 0.69, an average pion-pair transverse momentum equal to 0.43 GeV/c, and an average invariant mass squared equal to 0.84 GeV^2. The only serious discrepancies with experiment are the trajectory heights, which correspond to a kernel strength 2½-5 times too weak. The inclusion of the high-subenergy contribution and the inclusion of off-shell effects by several methods of off-shell continuation are considered, but none is found to be satisfactory. The importance of interference terms, due to different ways of arranging the final-state particles along the multiperipheral chain, is discussed. (auth)

40378 MULTICHANNEL MODEL OF THE K*(890). Carey, David C. (City Coll., New York). Phys. Rev., D; 2: 163-6 (1 Jul 1970).

The inelastic channels $K^*\pi$ and K are included in a three-channel model of the $I = \frac{1}{2}$ p-wave $K\pi$ amplitude. Feynman diagrams for vector-meson exchange are used as input to multichannel N/D equations, which are solved to obtain the scattering amplitude. Coupling constants which cannot be measured experimentally or calculated using SU(3) are obtained by employing $SU(6)_W$ in the rest system of one of the particles at a given vertex. The $K^*\pi$ channel, neglected in previous calculations, is observed to influence the amplitude strongly, but the width of the K*(890) is calculated to be 210 MeV or about four times the experimental value. (auth)

40379 APPLICATION OF A FINITE DISPERSION APPROACH TO THE CALCULATION OF THE $\omega \to \pi\pi\gamma$ DECAY. Aviv, R.; Nussinov, S. (Tel-Aviv Univ., Ramat Aviv, Israel). Phys. Rev., D; 2: 209-12(1 Jul 1970).

The contribution of high-mass states in the dispersion relation for decay amplitudes is considered. A finite dispersion relation (FDR) implemented by duality and finite-energy sum rules (FESR), is suggested as a useful tool for such calculations, and an application to the decay $\omega \to \pi\pi\gamma$ is done in some detail. (auth)

40380 PHYSICAL-REGION CONSTRAINTS ON LOW-ENERGY PARTIAL-WAVE AMPLITUDES. Roskies, Ralph (Yale Univ., New Haven). Contract AT(30-10)-2726. Phys. Rev., D; 2: 247-53(1 Jul 1970).

On the basis of analyticity, crossing, and positivity of the imaginary parts of the particle-wave amplitudes, inequalities on integrals are derived involving the low partial waves of elastic $\pi^0\pi^0$ scattering in the physical region. The integrals are sensitive only to the low-energy region, and can therefore be tested once a phase-shift analysis is given. The relations can be used to discriminate between various proposed $\pi^0\pi^0$ phase shifts. (auth)

40381 ARE THERE Jth ORDER RESONANCES OF SPIN J. Chan, Lai-him (Yale Univ., New Haven); Slansky, Richard; Sutherland, David. Phys. Rev. Lett.; 25: 482-5(17 Aug 1970).

It is suggested that the sequence ρ, A_2, R, S, ··· is a sequence of multipole resonances. Thus, the A_2 is a doubled resonance, the R is a tripled resonance, and so on. This hypothesis is consistent with present experimental data. The multipole resonance hypothesis is related to narrow-width resonance models in which undesirable states are eliminated with the aid of satellite Veneziano terms. The high-energy behavior is similar to normal Regge behavior. (auth)

40382 ON THE APPLICATION OF THE VENEZIANO AMPLITUDE TO ELECTROMAGNETIC MASS DIFFERENCE OF π AND K MESONS. Minamikawa, Toshiyuki (Tokyo Univ. of Mercantile Marine); Shibasaki, Ichiro; Watanabe, Tsunetoshi. Progr. Theor. Phys. (Kyoto); 43: 742-68(Mar 1970).

Applying the leading Veneziano amplitude to $\pi\rho \to \eta\omega_8$, the product of the coupling constants $G_{A_2\eta\pi}G_{A_2\rho\omega_8}$ is expressed by $4G_{\eta\rho\rho}G_{\omega_8\rho\pi}$. Using this result, the Veneziano amplitudes of $\pi\rho \to \pi\rho$ and $K\rho \to K\omega_8$ are applied to the calculation of electromagnetic mass difference of π and K mesons under the assumption of the field current identity, SU(3) symmetry, and gauge invariance. The results are quite excellent, namely $\Delta m_\pi = 7.5$ MeV and $\Delta m_K = -5.5$ MeV. Δm_K can be made negative by a term corresponding to tadpole diagram exchanging A_2 meson. In terms of the Veneziano model and field algebra, the whole integral is convergent, that is, the high energy behavior is milder by s^{-2} than Harari's argument. Further the coupling constants $G_{\omega\rho\pi} \sim 24$ MeV^{-1} and the strengths $G_S = 3.1$ and $\delta = G_S/G_D = 0.42$ of $A_1 \to \rho\pi$ decay are deduced by assuming $\Gamma_{\rho\pi\pi} = (5/7)m_\pi$. This gives $\Gamma_{A_1\rho\pi} \sim 85$ MeV. (auth)

40383 DUALITIES IN BARYON–ANTIBARYON SCATTERING. Kawarabayashi, Ken; Kitakado, Shinsaku; Yabuki, Haruichi (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 43: 769-88(Mar 1970).

Discussions are given of possible solutions for the finite energy sum rules (FESR), applied to baryon-antibaryon scattering, with or without assuming resonances in exotic channels. Exotic resonances, assuming they exist, are classified, as a result of factorization, according to 36-plet, 18-plet, 18-plet and nonet. It is then shown that these mesons are required to obey an equal spacing mass formula and nonet-like couplings, which are direct extensions of the ideal nonet scheme for 1^- and 2^+ mesons. When there are no resonances in exotic channels, the idea of duality between ordinary meson resonances is not applicable to baryon-antibaryon scattering. However, by extending the concept of the duality, it is possible to find a solution of the FESR. An explicit formula is constructed with such extended duality, where Regge cuts as well as Regge poles appear in the amplitude in question. (auth)

40384 CURRENT AS DYNAMICAL VARIABLES. Ozaki, Shoji. Progr. Theor. Phys. (Kyoto); 43: 842-3(Mar 1970).

Expressions for Lagrangians and stress tensors are given in terms of SU(2) × SU(2) chiral invariant currents for the cases of isospin-0 and isospin-1 scalar mesons. Continuity equations and equations of motion for the currents are also given. (L.B.S.)

Strong (Baryon No. = 1)

Refer also to abstracts 40356 and 40449.

40385 (COO-264-550) FIXED CUTS AND πN BACKWARD SCATTERING. Amann, R. F. (Chicago Univ., Ill. Enrico Fermi Inst.). Jun 1970. 11p. (EFI-70-35). Dep. CFSTI.

The present status of fermion Regge pole theory in backward $\pi N \to N\pi$ scattering is discussed. Fixed cuts are introduced to remove parity partners and a fit is attempted. However the dip in $\pi^+p \to p\pi^+$ scattering, a natural consequence of a nonsense wrong signature zero without the fixed cut, is now impossible to explain with a reasonable N_α residue. (auth)

40386 (COO-1428-170) DOUBLE-REGGE ANALYSIS OF THE REACTION $\pi^+p \to \pi^+\rho^0p$ AT 13.1 GeV/c. Lamsa, J. W.; Gaidos, J. A.; Willmann, R. B.; Ezell, C. (Purdue Univ., Lafayette, Ind.). Feb 1970. 14p. Dep. CFSTI.

A double-Regge-exchange model is compared to the reaction $\pi^+p \to \pi^+\rho^0p$ at 13.1 GeV/c. The reaction is well described if two diagrams (π/Pomeron-exchange and ρ/Pomeron-exchange) are added incoherently. (auth)

40387 (UCRL-19787) K^+p PARTIAL WAVE ANALYSIS AT 860 TO 1210 MeV/c. Hall, B. H.; Bland, R. W.; Goldhaber, G.; Trilling, G. H. (California Univ., Berkeley. Lawrence Radiation Lab.). 22 Apr 1970. Contract W-7405-eng-48. 8p. (CONF-700416-4). Dep. CFSTI.

Revised results of a partial-wave analysis of $K^+ + p$ elastic scattering at 860 to 1210 MeV/c are reported. These results are based on new polarization data and previously used differential cross sections. (J.F.P.)

40388 AKN COUPLING AND BACKWARD SCATTERING. Martin, A. D.; Michael, C. (CERN, Geneva). Phys. Lett.; 32B: 297-300(6 Jul 1970).

The $K^-n \to A\pi^-$ and $\pi N \to N\pi$ backward differential cross sections yield a ratio of nucleon Regge residues to AK and πN of 1.01 1.01 ± 0.3 (corresponding to $F/D = 0.57^{+0.11}_{-0.14}$). At the nucleon pole this extrapolates to $g^2_{AKN}/4\pi = 14.5 \pm 5$. (auth)

40389 CONVERGENCE OF FINITE ENERGY SUM RULES IN NON-FORWARD DIRECTIONS. Steiner, F. (Univ., Karlsruhe, Ger.). Phys. Lett.; 32B: 294-6(6 Jul 1970).

The regions of convergence of FESR and CMSR in nonforward directions following from axiomatic field and from Mandelstam analyticity are discussed. The results obtained in the latter case agree with the numerical estimates of Bowcock and Ng. However, in the case of $\pi^-p \to \pi^0n$ the region where FESR can be reliably used is much larger justifying the original application by Dolen, Horn and Schmid. (auth)

40390 HELICITY CONSERVATION IN DIFFRACTION SCATTERING AND DUALITY. Harari, H.; Zarmi, Y. (Weizmann Inst. of Science, Rehovot, Israel). Contract F-61052-68-C-0070. Phys. Lett.; 32B: 291-3(6 Jul 1970).

Gilman, Pumplin, Schwimmer and Stodolsky have recently proposed that Pomeron exchange terms conserve s-channel helicities. If the Pomeron is dual to s-channel background, it follows that s-channel helicity-flip amplitudes are dominated by resonances. A test of this assertion in the case of πN scattering indicates agreement with experiment. (auth)

40391 ON THE GENERALIZED πN POTENTIAL. A NEW REPRESENTATION FROM FIXED-t DISPERSION RELATIONS. Steiner, F. (Univ., Karlsruhe, Ger.). Fortschr. Phys.; 18: No. 1, 43-65(1970).

Starting from recent work a new representation of the left-hand cut contribution for the πN system is derived. This representation makes it possible to calculate the generalized πN potential accurately from phase shifts and high energy models, because it contains only the imaginary parts of the partial wave amplitudes in the physical region. The analytic properties, the region of convergence and the physical content of this representation is discussed. It is proposed to use this left-hand cut contribution in bootstrap calculations, because it is more reliable than the approximate expressions which have been used previously. The left-hand cut contributions are calculated and compared with the nucleon and Δ (1236) approximation for the $f^{(-)}_{0+}$, $f^{(-)}_{1-}$, $f^{(-)}_{1+}$ and $f^{(-)}_{2-}$ partial wave amplitudes. (auth)

40392 πN PARTIAL-WAVE RELATIONS FROM FIXED-t DISPERSION RELATIONS. Baacke, J.; Steiner, F. (Univ., Karlsruhe, Ger.). Fortschr. Phys.; 18: No. 1, 67-87(1970).

Starting from fixed-t dispersion relations a set of relations is derived for the πN partial wave amplitudes, generalizing previous work. The relations contain a single integral kernel, which is given in a closed form valid for arbitrary angular momentum. This kernel correlates the imaginary parts of all partial wave amplitudes with the partial wave amplitude under consideration. The partial wave relations give the correct threshold behavior. The region of convergence is determined in the case of axiomatic field theory and in the case of Mandelstam analyticity. Possible applications are discussed. (auth)

40393 MODEL FOR SCATTERING AT ALL ANGLES. Chu, Shu-yuan; Hendry, Archibald W. (Indiana Univ., Bloomington). Phys. Rev. Lett.; 25: 3-3-16(3 Aug 1970).

A simple absorptive optical model is presented for all scattering angles. For simplicity, the case of pion-nucleon charge-exchange scattering is discussed and it is shown how the model contains in a unified way the dip structures in both forward and backward di-

rections. For comparison with experiment, a fit to elastic π^+p scattering at 3 GeV/c is presented where data are available at all angles. (auth)

40394 HIGH-ENERGY TOTAL CROSS-SECTIONS AND THE ADLER-WEISBERGER RELATION. Thews, R. L. (Univ. of Rochester, N. Y.). Nuovo Cim.; 68A: 497-501(1 Aug 1970).

The Adler-Weisberger relation and other similar relations are re-examined without assuming unsubtracted dispersion relations. The results are essentially unchanged for any reasonable behavior of the high-energy cross sections, even if that behavior would cause the original dispersion integrals to diverge. (auth)

40395 QUARK-MODEL CLASSIFICATION OF LOW-MASS, $I = 1/2$ NUCLEON ISOBARS. Heusch, C. A.; Ravndal, F. (California Inst. of Tech., Pasadena). Phys. Rev. Lett.; 25: 253-6(27 Jul 1970).

A comparison is made of recent data on η-meson photoproduction with photoexcitation amplitudes calculated in the nonrelativistic quark model. This leads to definite multiplet assignments for all low-mass $I = 1/2$ nucleon isobars. In particular, no evidence is found for a radial sequence beyond $n = 2$. The assignment of P_{11} (1750) to an $n = 3$ second radially excited $[\underline{56},0^+]$ appears ruled out; instead, it is argued that consistency of results from photoproduction and diffraction scattering makes the configuration $[\underline{70},0^+]$ the best choice for this state. (auth)

40396 POMERANCHUK-OKUN RULE, PHASES AT ASYMPTOTIC ENERGIES AND POMERANCHUK THEOREM. Saleem, M.; Rafique, M. (Univ. of Pajab, Lahore). Lett. Nuovo Cim.; 4: 16-18(4 Jul 1970).

It is pointed out that a previously proposed model, from which the ratio of the real to the imaginary part of the scattering amplitudes for $\pi^- + p$ and $\pi^+ + p$ was calculated, is in contradiction with the Pomeranchuk-Okun rule. (J.F.P.)

40397 MEROMORPHIC AMPLITUDES WITH FERMIONS. Venturi, G. (Cambridge Univ., Eng.). Lett. Nuovo Cim.; 3: 753-6(13 Jun 1970).

An alternative approach to the inclusion of fermions in meromorphic amplitudes is suggested. This approach is considered simpler than previous approaches and more open to generalization to higher than four-point functions. Applications of the invariant representation in spin-space distribution of the pion-nucleon scattering amplitude, and of the construction of a ghost-free leading trajectory amplitude for meson-meson scattering in the quark model are discussed. (J.F.P.)

40398 SPIN-INDEPENDENT POMERON IN πN SCATTERING. Mannheim, P. D. (Tel-Aviv Univ., Israel). Lett. Nuovo Cim.; 3: 781-4(13 Jun 1970).

It is found that the Pomeron is a spin-independent object in $\pi + N$ scattering, and the assumption is examined that this is a general property in processes with more complicated spin configurations. The interaction $\gamma + N$ yielding a vector meson and a nucleon is studied. (J.F.P.)

40399 RECOIL EFFECTS IN A SCALAR-FIELD MODEL. Walter, R. (Univ., Stuttgart). Nuovo Cim.; 68A: 426-40 (1 Aug 1970).

Recoil effects in a scalar-field model which serves as a simple model for the real meson-nucleon problem are studied. A unitary transformation is used which diagonalizes exactly the Hamiltonian in the 1-nucleon subspace if the recoil is neglected. In order to treat recoil effects a second unitary transformation is performed which is perturbation-theoretical with respect to the recoil parameter and exact with respect to the coupling constant. By these unitary transformations the so-called dressed particles are introduced. The structure of the dressed particles composed of the original "bare" particles and the meson-nucleon scattering due to the recoil is investigated. (auth)

40400 HIGH-ENERGY PREDICTION OF THE REGGEIZED $U(6) \otimes U(6) \otimes O(3)$ ABSORPTION MODEL FOR $\pi^-p \to \pi^0n$. Collins, P. A.; Hartley, B. J.; Moore, R. W.; Moriarty, K. J. M. (Imperial Coll. of Science and Tech., London). (Phys. Rev., D; 1: 3195-6(1 Jun 1970).

The calculations of a previous paper on Reggeized $U(6) \otimes U(6) \otimes O(3)$ and absorptive correction cuts for $\pi^-p \to \pi^0n$ are extended to 70 GeV/c, an energy presently obtainable by the Serpukov accelerator. (auth)

40401 REACTION $\pi^+p \to \rho^0\Delta^{++}$ AT 13.1 GeV/c. Gaidos, J. A. (Purdue Univ., Lafayette, Ind.); Willmann, R. B.; Lamsa, J. W.; Ezell, C. R.; Meiere, F. T. Phys. Rev., D; 1: 3190-3((1 Jun 1970).

The differential cross section and ρ density-matrix elements for the reaction $\pi^+p \to \rho^0\Delta^{++}$ at 13.1 GeV/c are presented. The data are interpreted in terms of an absorption model with conventional pion exchange. The transverse ρ^0 production is compared with the predictions of vector dominance. (auth)

40402 REGGE-POLE FIT TO THE SERPUKHOV π^-p TOTAL CROSS-SECTION DATA. Rarita, William (Univ. of California, Berkeley). Phys. Rev., D; 1: 3185-7 (1 Jun 1970).

An additional Regge pole with a negative residue and a positive signature is suggested to fit the high-energy π^-p total cross sections recently measured at Serpukhov. Some experimental implications are given for the total cross sections and the ratio of the real to the imaginary part of the forward scattering amplitude of π^+p at high energies. (auth)

40403 APPLICATION OF THE GENERALIZED VENEZIANO MODEL TO $K^-p \to K^{*-}\pi^+n$. Collins, P. A.; Hartley, B. J.; Moore, R. W.; Moriarty, K. J. M. (Imperial Coll. of Science and Tech., London). Phys. Rev., D; 1: 3134-7 (1 Jun 1970).

The generalized Veneziano model is used in a phenomenological description of the process $K^-p \to K^{*-}\pi^+n$. Reasonable agreement with the main features of the experimental data for 6.0 and 10.0 GeV/c is obtained. (auth)

40404 DOUBLE-REGGE ANALYSIS OF THE REACTION $\pi^+p \to \pi^+\rho^0p$ AT 13.1 GeV/c. Lamsa, J. W.; Gaidos, J. A.; Willmann, R. B.; Ezell, C. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 1: 3091-3 (1 Jun 1970).

A double-Regge-exchange model is compared to the reaction $\pi^+p \to \pi^+\rho^0p$ at 13.1 GeV/c. The reaction is well described if two diagrams (π-Pomeranchukon exchange and ρ-Pomeranchukon exchange) are added incoherently. (auth)

40405 RELATION BETWEEN THE MULTI-REGGE MODEL AND THE MISSING-MASS SPECTRUM. Silverman, Dennis; Tan, Chung-I. (Princeton Univ., N. J.). Phys. Rev., D; 2: 233-6 (1 Jul 1970).

The integral equation approach to the multi-Regge peripheral model is applied to give the missing-mass spectrum with Regge behavior in s and M^2. A simple factorizable model for the double Regge coupling then gives the magnitude and t dependence of the cross section. This model is found to be in reasonable agreement with the backward $\pi^- + p \to p + X^-$ data. (auth)

40406 VENEZIANO MODEL FOR THE REACTION $\pi^-p \to \eta n$. Blackmon, Maurice L.; Wali, Kameshwar C. (Syracuse Univ., N. Y.). Phys. Rev., D; 2: 258-61 (1 Jul 1970).

A Veneziano model is proposed for the reaction $\pi^-p \to \eta n$. This reaction is interesting since only the A_2 trajectory can contribute in the t channel, and only $T = 1/2$ trajectories appear in the s and u channels. The terms in our model are limited to those which have leading asymptotic behavior in two channels. The intimate connection between resonance parameters is emphasized and both forward and backward cross sections. (auth)

40407 DISTRIBUTION OVER THE NUMBER OF PRONGS IN INELASTIC HADRONIC COLLISIONS. Chow, G. Y. (Saginaw Valley Coll., University Center, Mich.); Rix, J. Phys. Rev., D; 2: 139-42(1 Jul 1970).

The distribution over the number of prongs in inelastic hadronic collisions can be calculated by assuming (i) that the multiplicities of produced pions form a Poisson distribution, and (ii) that all the isospin final states are equally probable. The set of distributions for π^-p inelastic collisions were calculated, and agree well with experiments for all energies. (auth)

40408 CURVED ISOSPIN SPACE WITH TORSION AND PION-NUCLEON INTERACTIONS. Hamada, Minoru; Kimura, Toshiei (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 43: 830-41 (Mar 1970).

The chiral $SU(2) \times SU(2)$ transformations for a pseudoscalar meson are regarded as motions in a three-dimensional curved isospin space of constant curvature where the coordinates are the components of the pion field. A consistent representation for the isospin operator in the curved isospin space with torsion is proposed. From the kinematical part of a fermion Lagrangian density the interaction terms which contribute to both S- and P-wave pion-nucleon scattering amplitudes at low energies are derived at once through the covariant derivative for the fermion field. At the same time it follows the result that the unrenormalized value of the weak-coupling constant ratio g_A/g_V is unity. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 40356.

40409 (INR-1153) BINDING ENERGY OF A Λ PARTICLE IN NUCLEAR MATTER WITH NONCENTRAL Λ-N FORCES.

Dabrowski, J.; Hassan, M. Y. M. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 44p. Dep. CFSTI (U. S. Sales Only).

The binding energy of a Λ particle in nuclear matter, $B_\Lambda(\infty)$, is calculated in the frame of the self-consistent Brueckner K matrix theory. In the K matrix equations pure kinetic energies in the intermediate states are used. The expression for $B_\Lambda(\infty)$, which includes the rearrangement energy, is derived in the case of a ΛN interaction which is spin dependent, has a tensor and spin-orbit part and contains a hard core. Calculations were performed with the modified Herndon–Tang potentials and with a one-boson-exchange potential. The tensor suppression effect is estimated to be about 2 MeV, which includes important contributions of the ^3P ΛN interaction. The role of the self-consistency requirement in the tensor suppression effect is discussed. (auth)

40410 (RLO-1388-570) SPIN-ISOSPIN FORMALISM FOR MULTIPLE SCATTERING OF PIONS. Dean, N. W.; Friar, J. L. (Washington Univ., Seattle. Dept. of Physics). [1969]. Contract AT(45-1)-1388. 30p. Dep. CFSTI.

The scattering of pions by composite particles is considered, including effects of spin and isospin, using the Glauber formalism. The spin-isospin terms produce the group SU(4) in the scattering amplitude, which must be treated in the supermultiplet basis. Expressions are derived for pion scattering by light nuclei in terms of the pion-nucleon amplitudes, considering in particular the deuteron, He_3 and He_4. An application is also made to multiple scattering in the quark model. (auth)

40411 HIGH-ENERGY COLLISIONS OF HADRONS AND NUCLEI. Czyz, W. (CERN, Geneva. Inst. of Nuclear Physics, Krakow). Riv. Nuovo Cim.; 1: Special No., 42-58(1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

Some arguments are presented in favor of the high-energy, small-angle scattering model for nuclear collisions. It is argued that the main features of nuclear collisions are not dependent on the details of the internal structure of colliding particles; the formulas are then applied to the scattering of protons or pions from deuterons. Proton elastic scattering from oxygen-16 at 1 GeV is also discussed. (L.B.S.)

40412 ONE-MESON-EXCHANGE CONTRIBUTIONS TO NUCLEON-NUCLEON SCATTERING BELOW 400 MeV AND RELATION TO SCATTERING AT HIGHER ENERGIES. Bryan, R. A. (Texas A and M Univ., College Station). Nucl. Phys.; A146: 359-84(1970).

Nucleon–nucleon scattering is studied from the standpoint of meson resonances. The 0 to 400 MeV p–p and n–p data are fit by a sum of ρ, ω, π and ε Born contributions in the geometric-unitarization model, with the S-wave phase-shift parameters searched phenomenologically as in phase-shift analysis. The correspondence of this model with ordinary phase-shift analysis, which incorporates just the pion pole term, is brought out. Evidence for multi-uncorrelated meson exchange effects is indirectly obtained in that the ρ, ω and ε masses, when freed in the search, take on low values, much as the ρ and ω masses take on low values in single-pole fits to the nucleon electromagnetic form factors. However the π-mass, when freed, remains close to the physical mass. Thus a verification of the pion pole contribution to N–N scattering is provided by the lower partial waves. It is concluded that the multipole, geometric-unitarization model correctly depicts the major features of the N–N interaction but must be augmented by uncorrelated meson-exchange contributions. Nucleon–nucleon scattering in the range 400 to 800 MeV is briefly touched upon. Several predictions are pointed out for high-energy, high orbital angular momentum states. A plea is made for experimental measurements to test time-reversal invariance and conservation of isotopic spin. (auth)

40413 UNITARY PHENOMENOLOGICAL DESCRIPTION OF THREE-PARTICLE SYSTEMS. Noyes, H. Pierre (Stanford Univ., Calif.). Phys. Rev. Lett.; 25: 321-4(3 Aug 1970).

A general unitary phenomenological description of strongly interacting three-particle systems is developed in terms of two-particle phase shifts and binding energies, two-particle wave functions inside the range forces, and the three-body wave function in the region where all three force ranges overlap. The two-particle external and internal parameters are unambiguously separated from each other and the same parameters can be determined from many different experiments, while the three-body parameters refer to a specific system at a specific energy. (auth)

40414 MASSIVE LEPTON-PAIR PRODUCTION IN HADRON-HADRON COLLISIONS AT HIGH ENERGIES. Drell, Sidney D.; Yan, Tung-mow (Stanford Univ., Calif.). Phys. Rev. Lett.; 25: 316-20(3 Aug 1970).

On the basis of a parton model studied earlier the production process of large-mass lepton pairs from hadron–hadron inelastic collisions in the limiting region is considered, $s \to \infty$, Q^2/s finite, Q^2 and s being the squared invariant masses of the lepton pair and two initial hadrons, respectively. General scaling properties and connections with deep inelastic electron scattering are discussed. In particular, a rapidly decreasing cross section as $Q^2/s \to 1$ is predicted as a consequence of the observed rapid falloff of the inelastic scattering structure function νW_2 near threshold. (auth)

40415 APPLICATION OF OPTIMIZED POLYNOMIAL EXPANSIONS TO THE ANALYSIS OF p–p SCATTERING. Chao, Yung-an (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev. Lett.; 25: 309-13(3 Aug 1970).

The optimized polynomial expansions of p–p amplitudes represented by a chosen set of five invariant amplitudes are given and the transformation matrix between them and the conventional partial waves is worked out. Through this matrix, the results of the elastic p–p phase-shift analysis below 400 MeV done by the Livermore group are reexamined and very significant improvements are found. (auth)

40416 PHENOMENOLOGICAL ANALYSIS OF THE REACTION $p + p \to \pi^+ + d$. Brown, D. J. (Carleton Univ., Ottawa). Can. J. Phys.; 47: 2001-4(15 Sep 1969).

A simple Regge pole model is shown not to be adequate to explain the data in the region of incident-proton energy > 7 GeV. It is shown that the data can be explained if the process is dominated by a Regge cut. (auth)

40417 SCHWINGER TERMS, HARD PIONS, AND THE STRUCTURE OF THE DEUTERON. Weber, H. J. (Univ. of Virginia, Charlottesville). Phys. Rev., D; 2: 407-9(15 Jul 1970).

The npd vertex, Ward and Jacobi identities are used to evaluate the equal-time commutator (ETC) of the deuteron axial vector with the nucleon field. Schwinger terms are shown to be related to the deuteron wave function. They are important for nuclear short-range correlations. Ward identities yield the pole-term amplitudes for $pp \to d\pi^+$ and $pn \to d\gamma$ at threshold. Pion-induced nucleon–nucleon scattering is traced to the deuteron ETC with the weak axial-vector current. The Bjorken limit with respect to the deuteron yields the nonrelativistic limit of the reaction amplitudes. (auth)

40418 IMPULSE MODEL FOR THE REACTIONS $K^- + He \to Y + \pi + {}^3H$. Uretsky, J. (Argonne National Lab., Ill.); Bunnell, K. Phys. Rev., D; 2: 119-25(1 Jul 1970).

An impulse model is presented for the reactions $K^- + {}^4He \to Y + \pi + {}^3H$. The model incorporates the low-energy $\bar{K}$-nucleon parametrization of Kim. The calculation is done for capture at rest from both s and p atomic orbital states and also for kaon interactions in flight. The results are compared with experiment for the final states $\Lambda\pi^-{}^3He$ and $\Sigma^+\pi^-{}^3H$ from at-rest kaon interactions. (auth)

40419 LIMITED RESURRECTION OF THE BORN APPROXIMATION. Finkler, Paul (Univ. of Nebraska, Lincoln). Phys. Rev., D; 2: 173-8(1 Jul 1970).

It is shown that the ordinary Born approximation for pn and $p\bar{p}$ charge-exchange scattering correctly accounts for (1) the shape of the forward peak for $0 \le (-t) \le \mu^2/2$ at $P_L = 8$ GeV/c, and (2) the energy dependence of the cross sections at t = 0 in the energy range $P_L = 2$ to 8 GeV/c. This result is analogous to the well-known success of the electric Born approximation in π^+ photoproduction. It is then shown that the simplest interpretation of this surprising result within the framework of Regge-pole theory is in terms of the fixed poles which are allowed by unitarity in hadronic amplitudes at certain nonsense points of right signature. Finally, it is shown how such a fixed pole at a nonsense point of one helicity amplitude affects another amplitude for which the corresponding point is sense. (auth)

40420 LARGE-ANGLE SCATTERING BY OPTICAL POTENTIALS. Weingarten, Don (Columbia Univ., New York). Phys. Rev., D; 2: 201-8(1 Jul 1970).

The qualitative behavior of large-angle scattering by a rotationally invariant optical potential is investigated using the WKB approximation. It is shown that the strong s dependence exhibited by elastic proton–proton scattering requires an energy-dependent potential. The source of the inaccuracy of the eikonal approximation, at large angles, is found by comparing eikonal phase shifts with those given by the WKB approximation. (auth)

40421 POSSIBLE METHOD FOR DETERMINING THE PARITY OF Ω^+. Cha, Moon H. (Naval Ordnance Lab., Silver Spring, Md.). Phys. Rev., D; 2: 126-7(1 Jul 1970).

A phenomenological study of the strong reaction $\bar{\Omega}^+ + p \rightarrow K^+ + K^+ + K^0$ with low-energy $\bar{\Omega}^+$'s may determine the parity of $\bar{\Omega}^+$. Assuming S-wave interaction in the initial state, the presence of the final-state configuration in which the K^0 is at rest in the c.m. system would indicate that the parity of $\bar{\Omega}^+$ is odd. Other significant predictions based on features in the Dalitz plot are also presented. (auth)

40422 NUCLEON–NUCLEON BREMSSTRAHLUNG: AN S-MATRIX APPROACH. Burnett, T. H. (Univ. of California, San Diego, La Jolla). Phys. Rev., D; 1: 3098-3116(1 Jun 1970).

A covariant formulation of nucleon-nucleon bremsstrahlung is presented which is unitary and gauge invariant, and has a relatively simple form in the soft-photon limit. Applying the soft-photon approximation to experiment, a large discrepancy is found with the noncoplanar data taken in Harvard geometry, while the fit for the coplanar case is good. The inclusion of non-soft-photon dynamics using S-matrix methods is discussed. (auth)

40423 UNITARY MODEL OF REGGE CUTS. Dash, Jan W. (Univ. of Washington, Seattle); Fulco, J. R.; Pignotti, A. Phys. Rev., D; 1: 3164-7(1 Jun 1970).

A method is described for generating Regge cuts based on the multiperipheral model in the approximation of vanishing coupling of the Pomeranchuk trajectory to production processes. A formalism is used which explicitly satisfies the full unitarity equations, including inelastic terms, for all connected multiparticle production amplitudes as well as for the two-body amplitude. The sign of the Regge cut coincides with the sign of the cut in the absorptive model, and is opposite to that of the Amati–Fubini–Stanghellini cut. The results are applied to the recent Serpukhov pp data. (auth)

40424 EFFECT OF THE PION-MASS DIFFERENCE ON NUCLEON–NUCLEON SCATTERING PHASE PARAMETERS. Barker, Bruce M. (Louisiana State Univ., Baton Rouge); Haracz, Richard D. Phys. Rev., D; 1: 3187-9(1 Jun 1970).

The effect of the mass difference between charged and neutral pions on the two-pion-exchange (TPE) phase parameters is studied by using the mass-averaging procedure of El-Ghabaty, Gupta, and Kaskas. It is found that the differences between the TPE parameters for isotriplet p-p and p-n scattering are generally less than 1%, while these differences for the one-pion-exchange phase parameters are known to be as large as 10%. (auth)

40425 ON THE 3-MESON-EXCHANGE MODEL OF NUCLEON–NUCLEON SCATTERING BASED ON THE NAMBU–SALPETER–BETHE EQUATION. Murota, Toshiyuki (Hokkaido Univ., Sapporo); Noda, Matu-tarow; Tanaka, Fujio Progr. Theor. Phys. (Kyoto); 43: 852-4(Mar 1970).

The Nambu–Salpeter–Bethe equation is solved numerically in P and D partial waves of proton–proton scattering. The equation is reduced to simultaneous linear equations by applying the Gauss numerical integration formula. It is concluded that the parameter which give the experimental values of the $^1S_0$ phase shift fail to reproduce those of higher partial waves. (L.B.S.)

40426 NUCLEAR FORCE IN THE INNER REGION AND ONE-BOSON-EXCHANGE MODEL. Ueda, Tamotsu (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 43: 696-708(Mar 1970).

An explanation of the nuclear force in the inner region is presented in terms of the one-boson-exchange model with a nucleon–meson form factor correction. The model reproduces the experimental $^1S_0$ phase shift of nucleon–nucleon scattering quantitatively up to 3 GeV of an incident laboratory energy and gives also a fit to the experimental data of $^3P_0$, $^3P_1$, $^3P_2$, ρ_2, $^1D_2$, $^3S_1$, $^3D_1$, ρ_1, $^3D_3$, $^3D_2$, $^1P_1$ states in the elastic energy region with 1.6 standard deviation. (auth)

40427 DIFFRACTION PEAK AT SUPER-HIGH ENERGY BASED ON THE ISOBAR-PIONIZATION MODEL. Okamura, Hiroshi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 43: 721-30(Mar 1970).

The slope of the diffraction peak of elastic p–p scattering at super-high energy is calculated by relating it with the isobar-pionization model for inelastic scattering through van Hove's method and by using the data of Koshiba et al. The calculated value of the slope is not far from the experimental value at the accelerator energy. The pionization process has a very small effect, and the essential role is played by the isobars. (auth)

40428 FIREBALL MODEL WITH DOUBLE REGGE POLE EXCHANGE FOR MULTIPLE MESON PRODUCTION IN THE ACCELERATOR ENERGY REGION. Morii, Toshiyuki (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 43: 731-41(Mar 1970).

A simple model, namely the fireball model with double Regge pole exchange, is proposed for analyzing multiple meson production at high energies. In our model, the mass of the fireball is determined to be around 1 GeV from comparison with the experimental data on the pp reaction at 30 GeV/c. (auth)

Particle Invariance Principles and Symmetries

General

40429 CLEBSCH–GORDAN SERIES AND THE CLEBSCH–GORDAN COEFFICIENTS OF O(2,1) AND SU(1,1). Wang, Kuo-hsiang (Univ. of California, Berkeley). J. Math. Phys. (N. Y.); 11: 2077-95(Jul 1970).

The Clebsch–Gordan series of the O(2,1) group and its covering group SU(1,1) are derived for all cases except that of the supplemental series. The continuable Clebsch–Gordan coefficients (or equivalently, the Wigner coefficients) are explicitly expressed in terms of the generalized hypergeometric function ${}_3F_2$. The spectra in the decomposition of the product of the two principal series are discussed. The applications to the UIR of O(2,2) are also studied. (auth)

40430 WAVE EQUATIONS FOR UNSTABLE PARTICLES. Humi, Mayer (Univ. of Toronto). J. Math. Phys. (N. Y.); 11: 2222-4(Jul 1970).

A model is presented for the kinematical description of unstable particles in terms of equations which are invariant under broken IO(4,1). This model agrees with the current models of unstable particles, both those treating lifetimes and mass spectrum. It is shown that the concepts of generalized eigenfunction expansions and complex Fourier transforms enable one to deduce rigorously some of the guesses and assumptions made in these models. Finally, multiplets of unstable particles are dealt with, and some of the predictions of the theory are discussed. (auth)

40431 CHIRAL SYMMETRY AND THE KUO TRANSFORMATION. Okubo, S.; Mathur, V. S. (Univ. of Rochester, N. Y.). Phys. Rev., D; 2: 394-6(15 Jul 1970).

The various implications of a transformation recently suggested by Kuo in the model of Gell-Mann, Oakes, and Renner were investigated. (auth)

40432 SU(3) SYMMETRY AND ALGEBRAIC REALIZATIONS OF CHIRAL SYMMETRY. Ram Mohan, L. R. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1428. Phys. Rev., D; 2: 299-304(15 Jul 1970).

The algebraic realizations of chiral symmetry obtained by Weinberg are investigated for the case of SU(3) symmetry. When only p-wave interactions are taken into account, the algebraic realization of the first superconvergence condition is given by the Lie algebra of the group SU(2) ⊕ SU(6). The mass matrix obtained from the second superconvergence relation corresponds to degenerate masses within each of the multiplets (V = 0, 56) and (V = 2, 56). The consequences of particle classification under the group SU(2) ⊕ SU(6) are enumerated. (auth)

40433 CRITIQUE OF A PROPOSED DYNAMICAL GROUP FOR RELATIVISTIC QUANTUM MECHANICS. Noga, M. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 2: 304-10(15 Jul 1970).

The dynamical group $\tilde{G}_5$ for relativistic quantum mechanics phenomenologically suggested by Aghassi, Roman, and Santilli is derived from the analysis of symmetry properties of Lagrangians and corresponding equations of motion for a free relativistic particle. All physical observables such as position, momentum, angular momentum, and mass squared are represented by well-defined operators which close the algebra of the dynamical group $\tilde{G}_5$. The unitary irreducible representations of this group, which are possible states of the physical system, are found. The particles accommodated in the single unitary irreducible representations have various spins starting from the lowest spin value and going up to infinity in integral steps. The mass-squared operator $P_\mu P^\mu$ lies in the enveloping algebra of $\tilde{G}_5$, and its eigenvalues are not necessarily quantized and can have any positive or negative values. It is pointed out that this group has several failures and thus it cannot be accepted as the reliable dynamical group for particles within relativistic quantum mechanics. (auth)

40434 SOME PROPERTIES OF A HAMILTONIAN MODEL OF BROKEN SU(3) X SU(3) SYMMETRY. II. Kuo, T. K. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 2: 342-9(15 Jul 1970).

An inherent ambiguity of broken SU(3) × SU(3) symmetry is discussed. It is shown to arise from a discrete unitary transformation in the SU(3) × SU(3) space. For Hamiltonian models

for which the symmetry-breaking term transforms like the $(3,\bar{3}) + (\bar{3},3)$ representation, it is found that, in general, there are two such terms which describe the same physical system. Some consequences of this result are discussed. (auth)

40435 SPONTANEOUS BREAKDOWN OF CHIRAL SYMMETRY WITH LINEAR REALIZATIONS FOR ASYMPTOTIC FIELDS. Bessler, L.; Muta, T.; Umezawa, H.; Welling, D. (Univ. of Wisconsin, Milwaukee). Phys. Rev., D; 2: 349-56 (15 Jul 1970).

A method for considering the spontaneous breakdown of chiral symmetry without recourse to a particular Lagrangian model is presented. The physical or asymptotic fields are assigned to linear representations of chiral $SU_3 \times SU_3$ together with appropriate c-number addition to the scalar fields. This c-number addition manifests the spontaneous breakdown of the symmetry. Expansion of the interpolating fields in terms of asymptotic fields is introduced, which, together with the spontaneously broken chiral symmetry and the arbitrariness in the choice of interpolating fields, produces sum rules relating leptonic, semileptonic, and strong-coupling constants of $0^{\pm}$ and $1^{\pm}$ mesons. Results similar to those of current algebra are obtained with some notable differences. Among the most important is the appearance of the soft-meson amplitude as a consequence of our mechanism of spontaneous breakdown. Generalized soft-meson sum rules are obtained in an exceedingly simple way. In particular, new results are given for the semileptonic decays of the K meson, and generalized relations among strong-coupling constants and leptonic decays of $1^{\pm}$ mesons are derived. (auth)

40436 SPIN SPECTRUM DERIVABLE FROM ALGEBRAIC REALIZATIONS OF CHIRAL SYMMETRY. Pasupathy, J. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., D; 2: 357-61(15 Jul 1970).

Superconvergence relations are known to obey algebraic equations involving the spin and the mass. States of the same helicity fall into reducible representations of SU(2) ⊕ SU(2). When the helicity is $\pm\frac{1}{2}$, the two representations are related both by parity operation and spin raising or lowering operators in the helicity space. The combination of the two yields sufficient constraints to solve for a number of properties of low-lying resonances, with results in good agreement with experiment. (auth)

40437 UNITARY GENERALIZATION OF PAULI MATRICES. Ramakrishnan, Alladi (MATSCIENCE, Madras). Symp. Theor. Phys. Math.; 10: 51-7(1970).

From Symposia on Theoretical Physics and Mathematics, Madras, India. See CONF-690125.

It was previously shown that suitable linear combinations of L matrices which satisfy a given condition can be so defined as to obtain the elements of a Lie algebra and in particular those of SU(n) in their self-representation. A unitary generalization of Pauli matrices is derived in such a way as to make this connection quite clear. (J.F.P.)

40438 GENERALIZED CLIFFORD BASIS AND INFINITESIMAL GENERATORS OF UNITARY GROUPS. Ramakrishnan, Alladi; Raghavacharyulu, I. V. V. (MATSCIENCE, Madras). Symp. Theor. Phys. Math.; 10: 59-62(1970).

From Symposia on Theoretical Physics and Mathematics, Madras, India. See CONF-690125.

The intimate connection between the irreducible representation of a generalized Clifford algebra and the infinitesimal generators of U(n) and SU(n) groups and their direct products is emphasized. (J.F.P.)

40439 L-MATRICES AND THE FUNDAMENTAL THEOREM OF SPINOR THEORY. Ramakrishnan, Alladi; Santhanam, T. S.; Chandrasekaran, P. S. (MATSCIENCE, Madras). Symp. Theor. Phys. Math.; 10: 63-8(1970).

From Symposia on Theoretical Physics and Mathematics, Madras, India. See CONF-690125.

Two previous methods of generating higher-dimensional matrices with the requisite properties of a Clifford algebra, starting with a primative set of Pauli matrices are summarized. Also, a third and distinct method previously described using the fundamental theorem in spinor analysis is discussed. (J.F.P.)

Applications (Electromagnetic and Weak)

Refer also to abstract 40238.

40440 ASYMPTOTIC SU(2) SYMMETRY. I. BROKEN SU(2) MASS SUM RULES. Oneda, S. (Univ. of Wisconsin, Milwaukee); Matsuda, Seisaku. Phys. Rev., D; 2: 324-35(15 Jul 1970).

As a natural extension of the formulation of asymptotic SU(3) symmetry previously presented, a new formulation of asymptotic SU(2) symmetry is proposed. Intuitively speaking, it is assumed that both the SU(3) and SU(2) symmetries are well realized among particles of extremely high momenta where masses are not important. This point of view is formulated by assuming that, only in the asymptotic limit, the matrix elements of the SU(2) generators V_π^+ and V_π^- and also the SU(3) generator V_K [which, in the symmetry limit, are the isotopic-spin raising and lowering and the SU(3) raising operators, respectively] behave, to a reasonably good approximation, as if the symmetries were not broken. Mass sum rules are obtained by using these asymptotic SU(2) and SU(3) symmetries together with exotic charge commutators which involve the time derivative of V_π^* and which do not depend explicitly on the specific parameters of symmetry breaking. Assuming that the basis (and not effective) SU(2)-breaking interaction transforms like an SU(3) octet, the exotic commutators are $[\dot{V}_\pi^+, V_\pi^+] = [V_K^+, \dot{V}_\pi^-] = [V_K^+, \dot{V}_\pi^+] = 0$, etc. From them almost all the SU(2) sum rules previously obtained are reproduced on the assumption of effective octet dominance. However, contrary to previous results, the π^+ and π^0, for example, are no longer degenerate in mass. The mass difference is explained in terms of the $\eta^0 - \pi^0$ and $\eta'^0 - \pi^0$ mixings. A study is also made of the exotic commutators involving the axial-vector charges. The commutator $[\dot{V}\pi^+, A\pi^+] = 0$ is the least model-dependent one. From this an intermultiplet baryon mass formula is obtained involving the a decuplet and the b octet: $(\delta_a)^2 = (p_a)^2 - (n_a)^2$ (a and b are arbitrary). (p_a) and (n_a) denote the masses of the proton and neutron of the b octet, respectively. $(\delta_a)^2$ denotes the equal-squared-mass spacing of the decuplet, i.e., $(\delta_a)^2 = (\Delta_a^{++})^2 - (\Delta_a^+)^2 = (\Delta_a^+)^2 - (\Delta_a^0)^2 = (\Sigma_a^{*0})^2 - (\Sigma_a^{*-})^2$. The case of $a = \frac{3}{2}^+$ and $b = \frac{1}{2}^+$ coincides with the good sum rule of SU(6). For bosons, the exotic commutators such as $[\dot{V}_\pi^-, A_K^+] = [\dot{V}_\pi^+, A_K^+] = 0$, which are more model dependent than the $[\dot{V}_\pi^+, A_\pi^+] = 0$, produce the following general intermultiplet mass sum rule: $(K_\alpha^0)^2 - (K_\alpha^+)^2 = \text{const} \simeq 0.004\ (\text{GeV})^2$ (α is arbitrary). Here (K_α^+) denotes the mass of the K^+ meson belonging to the α octet. For the 0^- and 1^- octets, it implies $(K^0)^2 - (K^+)^2 = (K^{*0})^2 - (K^{*+})^2$, which is not inconsistent with present experiment. It is also shown that both the commutators, $[\dot{V}_\pi^+, V_\pi^+] = 0$ and $[\dot{V}_\pi^+, A_\pi^+] = 0$, give, in general, the same mass sum rule when they are applied to the same SU(2) multiplet. Sum rules for the axial-vector semileptonic hyperon decay couplings in broken SU(3) and SU(2) symmetries are also derived. (auth)

40441 SYMMETRY BREAKING IN RADIATIVE MESON DECAYS. Greenberg, D. F. (Carnegie-Mellon Univ., Pittsburgh). Nuovo Cim.; 68A: 459-68(1 Aug 1970).

Several different sources of SU_3 symmetry breaking, including ρ-X_0 mixing and the first Weinberg sum rule, are studied in the context of pole models for such decays as $\pi^0 \to \gamma\gamma$, $\eta \to \gamma\gamma$, $X_0 \to \gamma\gamma$, $\eta \to \pi\pi\gamma$ and $X_0 \to \rho\gamma$. Present data prefer some of the models over others. (auth)

40442 C INVARIANCE AND THE REACTION $e^- + e^+ \to \eta + \pi^0$. Sakuma, Tetsuro (Hokkaido Univ., Sapporo). Phys. Rev., D; 2: 254-6(1 Jul 1970).

It is shown how electron-positron annihilation into η and π^0 may be used to obtain information on C invariance in the electromagnetic interactions of hadrons. This is illustrated by studying the angular distributions in the c.m. system, the analysis of which should give a model-independent check on the validity of C invariance. (auth)

40443 ON THE UNIVERSAL V–A CURRENT–CURRENT INTERACTION WITH CP VIOLATION. Konuma, Michiji (Kyoto Univ.); Nakagawa, Masami. Progr. Theor. Phys. (Kyoto); 43: 799-807(Mar 1970).

A general universal V–A current–current interaction with CP violation proposed by complete analogy with the ordinary weak interaction is analyzed. A test of checking mutual consistency of the various components involved in the interaction is proposed; the test consists of the requirements that both the magnitude of the parity violating nuclear potential and that of the $\Delta S = 2$ transition do not affect those obtained from the ordinary weak interaction. It is shown that there is still but a little possibility for this kind of interaction to satisfy our requirements and that the CP violating phase difference in the amplitude of $K \to 2\pi$ decay is at most 10^{-3} in magnitude with results in $\eta_b \simeq \eta_{00}$. A discussion is given for comparison with other similar proposals. (auth)

Applications (Strong)

Refer also to abstracts 40347, 40408, and 40483.

40444 CHIRAL TRANSFORMATION PROPERTIES OF THE PSEUDOSCALAR–VECTOR–VECTOR INTERACTION. Alles, W. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna). Lett. Nuovo Cim.; 4: 137-46(25 Jul 1970).

In the framework of the effective Lagrangian and the field-current proportionality the transformation properties of the pseudoscalar–vector–vector interaction $\omega\rho\pi$ under the chiral SU(3) × SU(3) group are considered. It is demonstrated that it is not possible to have an SU(3) × SU(3) invariant interaction of two vector one pseudoscalar and one scalar meson when the vector mesons couple through their covariant curls in order to maintain the current-field proportionality. The decay widths and branching ratios of various mesons are discussed. (J.F.P.)

40445 MAGNETIC SUSCEPTIBILITY AND POLARIZATION OF PROTON IN THE BROKEN SYMMETRY SU(6). Dzhrbashyan, V. A. (Erevan Inst. of Physics). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 4: 298-306(1969). (In Russian).

Expressions for the magnetic susceptibility χ_p and polarization f_p of proton in the scheme of broken symmetry SU(6) are obtained. In the case of an external field of $H \ll 3(10)^{19}$ gauss these expressions coincide with the corresponding ones in SU(2) and are in agreement with the experiment. When $H \gg 3(10)^{19}$ gauss and $\mu / kT \to \infty$ the magnetic moment per unit-volume $I_p = \chi_p H$ for the proton is 1.52 N μ_p in the theory under consideration, while SU(2) gives $N\mu_p$. The maximal deviation of the proton polarization from the prediction of SU(2) is 3%. The exact expressions for χ_n and f_p, obtained in unbroken SU(6) are also given. Any arbitrary broken or unbroken symmetries will lead to the magnitude differing from $N\mu_p$ for maximal value (reached in case of saturation) of the magnetic moment per unit-volume for proton, if the same supermultiplet will contain the proton with another particle characterized by quantum numbers, allowing the transition magnetic moment between them. (auth)

40446 REGGE AMPLITUDE ARISING FROM SU(6)$_W$ VERTICES. Carlitz, R.; Kislinger, M. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., D; 2: 336-42(15 Jul 1970).

The spin structure of three-particle vertices may be determined from the quark model. Using these SU(6)$_W$ vertices in the Van Hove model, a Reggeized scattering amplitude is derived. In addition to Regge poles, there are necessarily fixed Regge cuts in both fermion and boson exchange amplitudes. The magnitudes of the pole and cut terms in an entire class of SU(6)-related reactions are determined by their magnitudes in a single reaction. As an example, the observed presence or absence of wrong-signature nonsense dips is explained in a class of reactions involving vector–meson exchange. (auth)

Field Theories

Refer also to abstract 39737.

General

40447 De SITTER SYMMETRIC FIELD THEORY. II. TENSORIAL AND SPINORIAL REALIZATIONS. Bakri, M. M. (International Centre for Theoretical Physics, Trieste, Italy); Ghaleb, A. F.; Hessein, M. I. J. Math. Phys. (N. Y.); 11: 2015-26(Jul 1970).

Plane-wave solutions with definite helicity are obtained for the field equations $(\delta_{\mu\nu}p_\nu + m\gamma_\mu)\psi = p_\mu\psi$. These equations are then rewritten in spinorial form. The relations between spinors, 4- and 5-dimensional tensors and spin-tensors, and the components of ψ are derived. (auth)

40448 INTERACTION OF PARTICLES IN NONLINEAR SCALAR FIELD THEORY. Rybakov, Yu. P.; Sutantio, V. Tr. Univ. Druzhby Narodov; 44: 100-12(1969). (In Russian).

The effect of nonlinearity on particle interactions is studied within the framework of the simplest model of classical nonlinear field theory, in which the real scalar field ϕ is described by the Lagrangian $L = -\frac{1}{2}F(p,s)$ where $p = (\partial_\mu\phi)^2$, $s = \phi^2$, and F is some smooth nonlinear function. The field equations admit solutions of both signs $\pm\phi$, which are conditionally made up of particles and antiparticles. From these are selected particle-like solutions which have no singular points and which are localized in a small region. Particle–particle and particle–antiparticle interactions are considered separately at short and long distances. With regard to the properties of interaction of real particles, the Lagrangian may be selected in the form $F(p,s) = (p + s - (\frac{1}{2})s^2) \exp(-\alpha(p + s - (\frac{1}{2})s^2))$, where α is a positive constant. This Lagrangian also satisfies the principle of correspondence with linear theory at large distances, and when α is small, leads to an equation with cubic nonlinearity. The condition of energy greater than zero determines the upper limit of α. Interaction is then considered at large distances for identical particles described by the simplest nonlinear equation $\Box\phi - \phi(1 - \phi^2) = 0$. Computations give constants of interaction close to the experimental values for pions, nucleons, and K-mesons: $g_\pi = 2.78$, $g_N = 17$, $g_K = 11.385$. (JPRS)

Quantum Field Theory

Refer also to abstracts 40284 and 40433.

40449 (DESY-70/21) P-AND F-WAVE SOLUTIONS OF RELATIVISTIC QUANTUM MECHANICS FOR BARYON EXCHANGE WITH CUTOFF. Katz, J.; Wagner, S. (Deutsches Elektronensynchrotron, Hamburg (West Germany)). May 1970. 29p. Dep. CFSTI (U. S. Sales Only).

The multichannel relativistic Schrödinger equation is solved for the even-parity partial-wave amplitudes with a potential obtained by computing the baryon exchange contribution to the pseudoscalar meson-baryon interaction. Physical values $g^2_{\pi NN}/4\pi = 14.6$ and $0.25 \leq g_F/(g_F + g_D) \leq 0.5$ are considered together with SU(3) relations among coupling constants and degenerate physical input masses. A cutoff is adjusted to make $N_\frac{3}{2}(1236)$ appear at the experimental energy. All p-wave πN phase shifts are in qualitative agreement with the CERN phase shifts at low energies and a quantitative fit of the P_{33} phase shift is obtained for an F/D ratio of $f = 0.48$. The calculated $\frac{3}{2}^+$ and $\frac{1}{2}^+$ baryon spectrum agrees qualitatively with the one obtained previously for an energy dependent baryon exchange potential without cutoffs, i.e., there is a $\frac{3}{2}^+$ decuplet and 27-plet resonances, an orbital excitation of the decuplet, and $\frac{1}{2}^+$ bound states in an octet representation as well as a second octet or 10 supermultiplets of resonances for $f < 0.32$ or $f > 0.32$. However, in contrast to previous results obtained with an energy dependent potential without cutoffs, exotic 27-plet resonances appear with extremely narrow widths, whereas normal second resonances and the Ω^- are missing, provided the cutoff is adjusted to $N_\frac{3}{2}(1236)$. Hence these results are less physical than the previous ones. (auth)

40450 STATUS OF QUANTUM ELECTRODYNAMICS. Farley, F. J. M. (Royal Military Coll. of Science, Swindon, Eng.). Riv. Nuovo Cim.; 1: Special No., 59-86(1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

The status of quantum electrodynamics is reviewed. The following conclusions are made. The theory of the electromagnetic field is validated over the range of 4×10^{-15} to 5×10^{10} cm. Super-low-energy and super-high-energy experiments appear to agree with quantum electrodynamics. The Lamb shift consistently comes out higher than theory, while the electron g-factor is too low. The muon g-factor is in better agreement, but is nevertheless high compared with its estimated error. (64 references) (L.B.S.)

40451 PROBLEM OF MACROCAUSALITY IN FIELD THEORY. Gromes, Dieter (Univ., Marburg, Ger.). Z. Phys.; 236: 276-87(1970).

After a critical discussion of some definitions of macrocausality a definition for causal propagation of observables, in particular of energy is proposed. This definition, which was already given in a preceding paper, is applied to various examples of local and nonlocal theories. Finally, the question of signals is dealt with, a question which needs some further consideration. The propagation of signals is discussed for local and nonlocal theories, including tachyon fields. (auth)

40452 SEARCHING SIMPLE PARAMETERS FOR LORENTZ TRANSFORMATION IN THE SCHWARZSCHILD GRAVITATIONAL FIELD. Ivanitskaya, O. S.; Syagio, I. S. (Inst. of Physics, Minsk. Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 1, 83-8(1969). (In Russian).

General equations were developed for searching simple parameters of nonholonomic Lorentz transformation in gravitational field. Special cases of Lorentz transformation with simple parameters, corresponding to the time calibration of the tetragravitational potentials were found for the Schwarzschild coefficient potentials. (R.V.J.)

40453 De SITTER SYMMETRIC FIELD THEORY. III. QUANTIZATION IN THE TUNG–WEINBERG BASIS. Bakri, M. M. (International Centre for Theoretical Physics, Trieste, Italy). J. Math. Phys. (N. Y.); 11: 2027-41(Jul 1970).

The de Sitter symmetric fields, satisfying the field equations $(\delta_{\mu\nu}p_\nu + k\gamma_\mu)\psi = p_\mu\psi$, are quantized in the Tung–Weinberg basis. The properties of the associated Green's and causal functions are studied. Transformations of the Hilbert space under CPT and inhomogeneous Lorentz transformations are given. A simple closed expression is obtained for the Shaw–Weinberg matrix tensor $f^{a_1 \cdots a_{2s}}_{m_1 m_2}$. (auth)

40454 ANHOLONOMIC BASES IN THE STUDY OF THE SPIN CONNECTION AND GAUGE POTENTIALS IN A RIEMANN SPACE. Treat, Richard P. (Univ. of California, Riverside. West Virginia Univ., Morgantown). J. Math. Phys. (N. Y.); 11: 2187-93(Jul 1970).

If parameters of a spin connection have a holonomy group which is the Lorentz group or a subgroup thereof and if a certain algebraic restriction involving the Riemann tensor, say R, is satisfied, then there is a one-to-one relation between the spin connection ${}^{1}\Gamma^{b}_{\mu a}$ and parameters of a Riemannian event connection $\Gamma^{\lambda}_{\mu\kappa}$ in a neighborhood of an assumed solution of the equations which establish the correspondence [see H. G. Loos, Ann. Phys. 25, 91(1963)]. One has, by the use of anholonomic bases in the Riemann space, simplified the equations which determine the map and have shown that if the algebraic condition R is satisfied, a one-to-one correspondence holds also in the large. The same method, involving anholonomic bases, has also been used to study the map between gauge potentials acting in the internal space formed by generators of local Lorentz transformations and parameters of connection of a Riemannian event space. An analogous theorem is proved which asserts that if R is satisfied then the correspondence between the gauge potential and the parameters of the event connection is one-to-one. (auth)

40455 FINITE INTEGRAL EQUATIONS FOR GREEN'S FUNCTIONS FOR $:\phi^4:$ COUPLING. I. Johnson, Rodney W. (Syracuse Univ., N. Y.). J. Math. Phys. (N. Y.); 11: 2161-5(Jul 1970).

A fully renormalized set of integral equations is derived for the Green's functions of a theory with $:\phi^4:$ coupling. (auth)

40456 EQUIVALENCE OF PERTURBATION-THEORY TECHNIQUES AND THE BETHE–SALPETER EQUATION FOR SUMMING FEYNMAN DIAGRAMS. Swift, Arthur R.; Tucker, Robin W. (Univ. of Massachusetts, Amherst). Phys. Rev., D; 2: 397-9(15 Jul 1970).

Polkinghorne's exact perturbation-theory equation for the leading Regge trajectory resulting from an infinite sum of ladder diagrams is shown to be mathematically equivalent to the partial-wave Bethe–Salpeter equation. Thus, the perturbation-theory equation can be used not only for the leading Regge trajectory, but for all secondary trajectories as well. (auth)

40457 AXIOMATIZATION OF THE THEORY OF RELATIVITY. Reichenbach, Hans. Berkeley, Calif.; University of California Press (1969). 225p. $7.95.

Translation of Axiomatik der Relativistischen Raum-Zeit-Lehre by Maria Reichenbach.

The discussion of the axiomatization of relativity theory covers the axioms and construction of the metric for both special and general relativity theory. (J.F.P.)

40458 LORENTZ TRANSFORMATION LAWS OF INTERACTING RADIATION-GAUGE FIELDS. Bender, Carl M. (Inst. for Advanced Study, Princeton, N. J.); Griffiths, David J. Phys. Rev., D; 2: 317-23(15 Jul 1970).

Interacting quantum electrodynamics with the electric current j^{μ} unspecified is considered and the homogeneous Lorentz group transformation laws of the "vector" potential A^{μ} are computed in the radiation gauge. It is shown that A^{μ} decomposes uniquely into a direct sum of an infinite number of linear, infinite-dimensional, nonunitary, indecomposable representations of the homogeneous Lorentz group. One of these representations has spin-multiplicity 2, belongs to a class of representations recently analyzed by Gel'fand and Ponomarev, and may be the first recognized physical example of this class of representations. Finally, the noninteracting limit is shown to reduce correctly to the free-field case in which the transformation properties of the "vector" potential are already known. (auth)

40459 REPLY TO KARLOV'S ARTICLE ON THE TRANSFORMATION OF FORCE IN SPECIAL RELATIVITY. Ray, J. R. (Clemson Univ., S. C.). Lett. Nuovo Cim.; 3: 739-41(13 Jun 1970).

The transformation of force in special relativity is considered, and it is found that the conventional result is correct. (J.F.P.)

40460 TRANSFORMATION OF FORCE IN RELATIVISTIC STATICS. Rindler, W. (Univ. of Texas, Dallas). Lett. Nuovo Cim.; 3: 742-3(13 Jun 1970).

A previous transformation of force in relativistic statics is considered. After the correction of an error no logical contradiction remains for the transformation of a relativistic three-force in static situations. (J.F.P.)

40461 BJORKEN–JOHNSON–LOW LIMIT IN PERTURBATION THEORY. Polkinghorne, J. C. (Cambridge Univ., Eng.). Nuovo Cim.; 68A: 441-58(1 Aug 1970).

The Bjorken-Johnson-Low limit is analyzed in perturbation theory with currents constructed from fermion fields with a neutral gluon interaction. Diagrams with many loops can be treated. For those which are not divergent it is shown that the limit is violated in well-defined circumstances by terms involving powers of logarithms. The maximum power of $\ln(-q_0^2)$, and its numerical coefficient, are directly related to the degree of divergence, and its coefficient, of an associated vertex part. The terms of order q_0^{-1} are shown to correspond to renormalized vertex parts with the vertex given by the canonical commutator together with a series of dynamical corrections to it. Some simple diagrams requiring renormalization are also analyzed. Coefficients of $\ln(-q_0^2)$ can again be related to those of divergencies in self-energy and vertex parts except that there is now a minus sign multiplying them. (auth)

40462 THEORY OF PARTICLES TRAVELING FASTER THAN LIGHT. I. Sudarshan, E. C. G. (Syracuse Univ., N. Y.). Symp. Theor. Phys. Math.; 10: 129-51(1970).

From Symposia on Theoretical Physics and Mathematics, Madras, India. See CONF-690125.

The discussion of particles traveling faster than light covers the postulate concerning the speed of light, relativistic classification of particles, the law of composition of velocities, problems with faster-than-light particles, and the switching principle. Also covered are causality, the role of faster-than-light particles in relativistic physics, and restoration of the initial value problem. (J.F.P.)

40463 MODEL OF AXIOMATIC FIELD THEORY. Efremov, A. V.; Rizov, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 4: 7-10(Jul 1970). (In Russian).

In the model of scalar field, the double commutator of which is assumed to be linear in the field, the generators of the corresponding representation of the Poincaré group are found. The energy operator is not positive definite and the spectral condition is broken. (auth)

40464 EQUIVALENCE PROBLEMS IN MODELS WITH INFINITE RENORMALIZATIONS. Guerra, F. (Univ., Naples. Istituto Nazionale di Fisica Nucleare, Naples). Nuovo Cim.; 68A: 258-80(21 Jul 1970).

The conditions for the equivalence between two quantum field-theoretical models with infinite mass and charge renormalizations are investigated, taking into account not only observable effects, but also the details of Hilbert-space formalism. The models are of Lee-model type with relativistic kinematics, with interactions $V \rightleftharpoons N\theta$ and $N\theta \rightleftharpoons N\theta$ respectively. (auth)

40465 COVARIANT THEORY OF THE QUANTIZED ELECTROMAGNETIC FIELD WITH ONLY PHYSICAL PHOTONS. Mathews, P. M. (Univ. of Madras). J. Phys., A (London); 3: 357-67(Jul 1970).

A manifestly covariant procedure for quantization of the electromagnetic potentials A^{μ} is presented, wherein only two types of photons with space-like polarization vectors find a place. The nonappearance of unphysical photons corresponding to the longitudinal and scalar photons of other formulations is due to our insistence from the beginning that the Lorentz condition be satisfied (as an operator equation) by the A^{μ}, and it makes the introduction of any indefinite metric unnecessary. The wave functions of the physical photons, which appear in the plane wave expansion of the A^{μ}, are definable in principle only to within arbitrary gauge terms. Consequently, expressions for the commutator between the field components and for the photon propagator contain indeterminate terms which serve merely to ensure that A^{μ} is coupled only to conserved currents; they do not contribute to physical matrix elements. The theory therefore leads to the same results in quantum electrodynamics as earlier formulations, but in a manifestly Lorentz covariant and gauge invariant fashion and without recourse to concepts like the indefinite metric or any other ad hoc prescriptions. (auth) (UK)

40466 THREE-DIMENSIONAL RELATIVISTIC EQUATIONS FOR SYSTEM OF TWO PARTICLES WITH UNEQUAL MASSES. Kadyshevskii, V. G.; Mateev, M. D.; Mir-Kasimov, R. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 692-700(Mar 1970). (In Russian).

Generalization of relativistic quasipotential equation to the case of particles with unequal masses is considered. It is shown that the relativistic two-body problem may be reduced to the problem of motion of a particle with mass equal to the geometrical mean of the two masses in a quasipotential field. (auth)

Gravitation and General Relativity

Refer also to abstract 39742.

40467 (KFKI-70-11-HEP) ON THE SPINOR TREATMENT OF STATIONARY SPACE-TIMES. Perjes, Z. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1969]. 27p. Dep. CFSTI (U. S. Sales Only).

A generalized SU/2/ spinor calculus is established on the "background space" V_3 of the stationary space-time. The method of spin coefficients is developed in three dimensions. The stationary field equations can be put to a form which in V_3 is analogous to the Newman-Penrose equations. A V_3 filling family of curves is determined by the gravitational field and is called the eigenray congruence. Stationary space-times may be characterized by the geometric properties of eigenrays. The relation of this classification to the algebraic ones is discussed. The method of solving the equations obtainable for various classes is illustrated on the case of nonshearing geodetic eigenrays. Assuming asymptotic flatness, the Kerr metric is obtained. (auth)

40468 PROBLEM OF AVERAGING THE GRAVITATIONAL FIELD IN MATERIAL MEDIA. Mitskevich, N. V. Tr. Univ. Druzhby Narodov; 44: 137-43(1969). (In Russian).

On the basis of equations of deviation of geodesics in the general theory of relativity, the concept of relative intensity of a gravitational field and also (with the use of the tensor analogy of equations of electromagnetic and gravitational fields) the concept of gravitational induction and polarization are developed. By definition, gravitational polarization is described by a tensor, and gravitational induction is described by another tensor. It is shown that, by analogy with equations of electrodynamics, the gravitational field equations may be represented as ordinary Bianchi identities (for intensity) and the divergence equation $D^{\alpha}_{\mu\nu;\alpha} = 0$ (for induction). This analogy is used to analyze the problem of averaging equations of gravitational and electromagnetic fields in material media. The problem of the rate of propagation of gravitation waves in a material medium is considered. A hypothesis is proposed for the existence of the Cerenkov radiation effect for gravitation waves. (JPRS)

40469 ISOTROPY OF SPACE. Gorini, Vittorio (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan); Zecca, Antonio. J. Math. Phys. (N. Y.); 11: 2226-30(Jul 1970).

It is well known that it is possible to deduce the Lorentz transformations solely on the basis of the principles of relativity, space-time homogeneity, and isotropy of space, without making any use of the principles of reciprocity and of the invariance of the velocity of light. Here a rigorous and simple formulation of the isotropy principle is put forward, which appears to be more general than those usually presented and which, together with the results of a preceding paper, allows one to carry out such a deduction in the physical case of a 4-dimensional space-time in a straightforward and considerably simplified way. (auth)

40470 SELF-INTERACTION OF GRAVITATIONAL RADIATION. Couch, W. E. (Univ. of Texas, Austin); Torrence, R. J. J. Math. Phys. (N. Y.); 11: 2096-2114(Jul 1970).

A nonsingular, sourceless, first-order pulse of gravitational radiation imploding from infinity to a focus and then exploding back out to infinity is examined to second order. It is found that, contrary to what might be expected, the nonsingular second-order field contains no radiation. In space-time regions outside of the pulse, the second-order field is nonvanishing only in the region with retarded times earlier than the passing of the exploding pulse and advanced times later than the passing of the imploding pulse. In this region, the second-order field is that of a Schwarzschild mass, plus a nonradiative quadrupole, plus a nonradiative sixteen pole. (auth)

40471 LOCAL GAUGE FIELDS IN GENERAL RELATIVITY. Treat, Richard P. (Univ. of California, Riverside. West Virginia Univ., Morgantown). J. Math. Phys. (N. Y.); 11: 2176-86(Jul 1970).

The carrier space for internal degrees of freedom is assumed to be the 6-dimensional space spanned by generators $L_{ik}{}^{\lambda}$ of local Lorentz transformations defined at each event of a Riemann space. Gauge potentials are introduced in this internal space which are like the Yang-Mills potentials except that they are related to parameters of the event connection $\Gamma^{\lambda}_{\mu k}$ by a map which involves the $L_{ik}{}^{\lambda}$ as connecting quantities. The map is similar to the one which relates the Dirac spin space and spin connection to the Riemannian geometry of event space. An algebraic uniqueness condition is shown which is necessary and sufficient for the map to be one-to-one in a neighborhood of a solution $\Gamma^{\lambda}_{\mu k}$ of the mapping equations. The metric field is undetermined by a uniform scale transformation. If the gauge potentials have an internal holonomy group which is a subgroup of the Lorentz group and satisfy the free Yang-Mills equations, and if the uniqueness condition is satisfied, then the $\Gamma^{\lambda}_{\mu k}$ committed by the inverse map automatically satisfy the free Einstein field equations, indicating that only the gravitational field is included in this mathematical framework. In an attempt to include nongravitational properties of matter, one then considered internal holonomy groups larger than the Lorentz group. The part of the gauge potentials causing the enlargement is shown to form a current which may be interpreted as a source of the gravitational field. (auth)

40472 TENSOR HARMONICS IN CANONICAL FORM FOR GRAVITATIONAL RADIATION AND OTHER APPLICATIONS. Zerilli, Frank J. (Palmer Physical Lab., Princeton, N. J.). J. Math. Phys. (N. Y.); 11: 2203-8(Jul 1970).

An analysis is made of the relation between the tensor harmonics given by Regge and Wheeler in 1957 and those given by Jon Mathews in 1962. This makes it possible to use the Regge-Wheeler harmonics, which are given in terms of derivatives of scalar spherical harmonics, for calculations while using Mathew's form of the harmonics [linear combinations of the elements of the product basis formed from a basis for scalar functions on the 2-sphere and a basis for symmetric tensors such that the product basis is split into sets which transform under the irreducible representations of SO(3)] to elucidate the properties of tensor harmonics. Thus, a convenient orthonormal set of harmonics is given which is useful in studying, for example, gravitational radiation. (auth)

40473 AXIALLY SYMMETRIC FIELDS IN GENERAL RELATIVITY. Misra, R. M. (Univ. of Gorakhpur, India). Phys. Rev., D; 2: 410-12(15 Jul 1970).

Some general remarks regarding static metrics with axial symmetry are made. A particular solution of this class for the interior of a body which joins smoothly with the exterior general Weyl fields at the boundary of the body is discussed. This solution, though it shows all the features of a solution recently discussed by Marek, is better in the sense that the matter admitted by it is physically more reasonable. (auth)

40474 CLASS OF EXACT SOLUTIONS OF THE EINSTEIN-MAXWELL EQUATIONS. Gautreau, Ronald (Newark Coll. of Engineering, N. J.); Hoffman, Richard B. Phys. Rev., D; 2: 271-2(15 Jul 1970).

Weyl has found a particular class of static electromagnetic vacuum solutions for fields that depend on at most two spatial variables. A report is given on another class of electromagnetic vacuum solutions which are not of Weyl's type. As with Weyl's case, these new solutions are generated from functions that formally satisfy the two-dimensional Newtonian Laplacian equation. (auth)

40475 ELEMENTARY MODEL FOR QUANTUM GRAVITY. Klauder, John R. (Bell Telephone Labs., Inc., Murray Hill, N. J.); Aslaksen, Erik W. Phys. Rev., D; 2: 272-6(15 Jul 1970).

An elementary model of the gravitational field in the presence of external sources is studied. This model has positivity requirements, invariance under transformations, and nonlinear equations of motion, all of which are analogs of similar properties in the full theory. The classical solutions of the "free" version of this model exhibit singularities, but these are removed in the quantum theory. (auth)

40476 SOME PROPERTIES OF GRAVITATIONAL FIELDS OF MAGNETIC TYPE. Narain, Udit (Meerut Coll., India). Phys. Rev., D; 2: 278-80(15 Jul 1970).

Some properties of the gravitational fields of magnetic type are investigated, using timelike congruences and the Bianchi identities. Null eigendirections of the conformal tensor are determined without any assumption regarding the nature of the sources of the gravitational field. Some relations between the kinematical quantities of the timelike congruences and the curvature of space-time were derived. The results reduce to those of empty space when the Ricci tensor is taken to be zero. These empty-space equations lead us to a scalar potential which satisfies the field equation of Newton's theory of gravitation. (auth)

40477 WAVE SOLUTIONS OF GAUGE INVARIANT GENERALIZATION OF FIELD THEORIES WITH ASYMMETRIC FUNDAMENTAL TENSOR IN A $V_2 \times V_2$ SPACE-TIME. Lal, K. B.; Khare, D. C. (Univ. of Gorakhpur, India). Tensor; 21: 333-9(Sep 1970).

A gauge invariant generalization of the Einstein field equations as given previously by Buchdahl in a $V_2 \times V_2$ space-time is considered. It is shown that under certain conditions gauge invariant solutions exist which are also solutions of Einstein unified field equations. (J.F.P.)

40478 RECIPROCAL STATIC METRICS AND NONLINEAR LAGRANGIANS. Buchdahl, H. A. (Australian National Univ., Canberra). Tensor; 21: 340-4(Sep 1970).

Since nonlinear Lagrangians are considered in general rela-

tivity theory, it is inquired whether there exist Lagrangians such that when certain equations are satisfied by a static solution then they will also be satisfied by the reciprocal solution. (J.F.P.)

40479 ANALOGUE OF BIRKHOFF'S THEOREM IN SCHROEDINGER'S UNIFIED FIELD THEORY. Tiwari, R. N. (Indian Inst. of Tech., Kharagpur, India). Tensor; 21: 345-8 (Sep 1970).

The Birkhoff theorem in the general theory of relativity is extended to the Schroedinger unified field theory in para form and also to the Einstein unified field in weaker form. (J.F.P.)

40480 WAVE SOLUTIONS OF SCHROEDINGER'S UNIFIED FIELD THEORY IN A $V_2 \times V_2$ SPACE-TIME. Lal, K. B.; Khare, D. C. (Univ. of Gorakhpur, India). Tensor; 21: 349-53(Sep 1970).

It is found that if Schroedinger's unified field equations are considered in a $V_2 \times V_2$ space-time, the wave solutions of both the strong and the weak field equations exist. (J.F.P.)

40481 NOTE ON THE BEL-ROBINSON SPINOR. Zund, J. D. (Virginia Polytechnic Inst., Blacksburg). Tensor; 21: 354-8 (Sep 1970).

The two-component van der Waerden spinor equivalent of the Bel-Robinson tensor for general relativity is examined. Also a canonical form for this spinor is exhibited in the various Bel-Petrov types. (J.F.P.)

40482 SPACE-TIMES OF HOFFMAN AND PERES. Takeno, Hyoitiro; Kitamura, Shin-ichi (Hiroshima Univ. Fukui Univ., Japan). Tensor; 21: 359-66(Sep 1970).

The parallel vector fields, recurrency, and KS-type properties of Hoffman and Peres space-times are investigated. Some intimate connections among these equations are clarified. (J.F.P.)

40483 SYMMETRY OF THE GRAVITATIONAL FIELD. Carmeli, M. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Lett. Nuovo Cim.; 4: 40-4(4 Jul 1970).

The Einstein equations of gravitation are reformulated using techniques similar to those used in strong interactions. The SL(2,C) group is used. (J.F.P.)

40484 MECHANICAL OSCILLATIONS INDUCED BY PENETRATING PARTICLES. Beron, B. L.; Boughn, S. P.; Hamilton, W. O.; Hofstadter, R.; Martin, T. W. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 3, 65-6(Jun 1970).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-700301.

Investigations into the production of mechanical oscillations in aluminum cylinders by high energy electrons reveal that the mechanism of excitation is a "hot rod model" in which the shower deposists heat in the bar and the hot zone expands causing mechanical vibrations. The conversion efficiency of this process is evaluated in these experiments. The hot rod mechanism does not present a significant background for gravitational events from cosmic rays in room temperature gravitation radiation detectors. (auth)

40485 O^+, T = 2 STATES IN A = 40 NUCLEI. Jolly, H. P. (Southeastern Massachusetts Univ., North Dartmouth); Hubbard, L. B. Contract AT(30-1)-2098. Phys. Rev., C; 1: 1979-81(Jun 1970).

The O^+, T = 2 states of A = 40 nuclei are calculated by diagonalizing representative nuclear forces in the complete 2 $\hbar\omega$ basis of 80 states. Both a phenomenological force and a realistic force are employed. When the single-particle energies are corrected in a manner suggested by previous calculations, the realistic force makes a good fit to the experimental data. The results for the phenomenological force and the traditional single-particle energies do not fit the data. Many more low-lying O^+ states in ^{40}Ar are predicted than are seen experimentally. (auth)

Scattering Theory

Refer also to abstract 40210.

40486 (IFA-FT-61) ABOUT THE BEST STABILITY IN WEIGHTED DISPERSION RELATIONS. Nenciu, G. (Institutul de Fizica Atomica, Bucharest (Romania)). 1970. 6p. Dep. CFSTI (U. S. Sales Only).

Analytic continuation using weighted dispersion relations is discussed. This method is used for the analyticity of the scattering amplitude to obtain supplementary information from experimental data. (J.F.P.)

40487 (JINR-P2-5100) RELATIVISTIC THREE BODY PROBLEM IN RELATIVE VARIABLES. Vinogradov, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 26p. (In Russian). Dep. CFSTI (U. S. Sales Only).

On the basis of the three-dimensional formulation of quantum field theory the Lorentz-covariant three-body theory is constructed in momentum space. Relativistic Jacoby momenta are introduced by means of the additional operation of 4-vectors in the Lobachevsky space. It is shown that the motion of the center of mass system can be separated and the problem is formulated only in relative variables as a direct generalization of the nonrelativistic theory. The three-dimensional relativistic analog of the Faddeev equations for the scattering amplitude as well as the analog of the Schrödinger equation for three body system are obtained. The system satisfies three-body unitarity and the correspondence principle. (auth)

40488 (JINR-P4-5149) FIXING OF THE INDEFINITENESS OF THE RESULTS IN MULTICHANNEL SCATTERING THEORY. Zakharev, B. N.; Shmonin, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 11p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The method of solving multichannel scattering problems is proposed which permits one to give the strict two-sided estimation of a possible error for a computed value of any observable magnitude. (auth)

40489 DUALITY AND GUAGE PROPERTIES OF TWISTED PROPAGATORS IN MULTI-VENEZIANO THEORY. Alessandrini, V. (CERN, Geneva); Amati, D.; Le Bellac, M.; Olive, D. Phys. Lett.; 32B: 285-90(6 Jul 1970).

The duality and gauge properties of a twisted propagator in the operator expression of the multi-Veneziano theory satisfying double twist invariance operatorially are displayed. It is then shown that the trace calculation of an arbitrary one-loop diagram gives the same result as that recently obtained using projection operators to eliminate spurious states. (J.F.P.)

40490 SOLUTION OF A THREE-BODY SCATTERING PROBLEM IN ONE DIMENSION. Marchioro, C. (Univ., Rome). J. Math. Phys. (N. Y.); 11: 2193-6(Jul 1970).

The scattering problem of three equal particles interacting via repulsive inverse-cube forces is solved in one dimension both in the classical and the quantal cases. The quantal S matrix is similar to that produced by repulsive δ-function interaction of infinite strength. (auth)

40491 PERATIZATION OF A CLASS OF EXPONENTIALLY SINGULAR POTENTIALS. Frank, William M.; Land, David L. (Naval Ordnance Lab., Silver Spring, Md.). J. Math. Phys. (N. Y.); 11: 2041-57(Jul 1970).

First, second, and third peratizations are performed for evaluation of the scattering length for repulsive potentials of the form $V(r) = gr^{-m} \exp(\lambda/r)$ with m an integer ≥ 4. For $m = 4$ a nontrivial result is found in second and higher peratization which has the same weak-coupling limit as the exact answer and agrees with the result of Calogero and Cassandro. For $m > 4$ one finds a zero result in both first, second, and third peratization, suggesting the inadequacy of the procedure as generally applied. The procedure of separate peratization of numerator and denominator of a ratio which is employed is discussed at length. The optimum n method is introduced in the course of this discussion as a powerful and convenient method of evaluating the scattering length without summing the appropriate series. It also clarifies the limitations of the peratization approximation. A modification of the peratization procedure is suggested which has promise of being a more successful approximation scheme. (auth)

40492 PERATIZATION OF LOGARITHMICALLY SINGULAR POTENTIALS. Frank, William M.; Land, David J. (Naval Ordnance Lab., Silver Spring, Md.). J. Math. Phys. (N. Y.); 11: 2058-62(Jul 1970).

First and second peratizations are performed for a wide class of repulsive potentials with singular behavior near $r = 0$ of the form $L(r)r^{-m}$ ($m > 3$), where $L(r)$ is "logarithmically singular" at the origin. More precisely, when $L(r)$ is of the class of "slowly varying functions," i.e., functions such that $rL'(r)/L(r) \to 0$ as $r \to 0$, first peratization gives a (generally infinite) constant multiple of the result for the r^{-m} potential. Second peratization for a wide class of slowly varying function offers no substantive improvement. (auth)

40493 APPROXIMATE SOLUTIONS OF THE UNITARITY EQUATION. Eftimiu, C. (Univ. of Missouri, St. Louis). J. Math. Phys. (N. Y.); 11: 2070-4(Jul 1970).

The possible use of the classical Newton approximation method,

as extended by Kantorovich to Banach spaces, is discussed in connection with the problem of solving the unitarity equation for the phase of a scattering amplitude, in terms of the corresponding differential cross section. (auth)

40494 MANDELSTAM REPRESENTATION IN POTENTIAL SCATTERING. Chela-Flores, Julian (Queen Mary Coll., London). J. Math. Phys. (N. Y.); 11: 2013-15(Jul 1970).

A simpler and more general proof of the Mandelstam representation based on Hartog's theorem is presented within the framework of potential scattering; the potential is chosen to be a superposition of the Yukawa type with no further restrictions. (auth)

40495 FEYNMAN RULES FOR GRAPHS WITH EXCHANGE OF REGGE PARTICLES. Dolfini, R. (Istituto Nazionale di Fisica Nucleare, Milan). Lett. Nuovo Cim.; 4: 129-32(25 Jul 1970).

The Feynman rules are generalized to graphs with Regge particles. These rules suggest a very simple general method to proceed beyond a simple Regge polology. The factorizability of the residues is the only assumption made. A prescription for graphs with vertices with two spinless particles and one Regge particle is found. (J.F.P.)

40496 HIGH-ENERGY APPROXIMATIONS IN POTENTIAL SCATTERING THEORY. Moore, R. J. (Univ. of Texas, Austin). Phys. Rev., D; 2: 313-16(15 Jul 1970).

The relationship between the eikonal approximation of Glauber and the impact-parameter approximation of Blankenbecler and Goldberger is clarified. This is done by comparing the approximate forms for the scattering amplitude for nonrelativistic scattering by a potential with the Born expansion, which at high energy assumes the natural form of a series of terms in inverse powers of the center-of-mass momentum p. It is found that both approximations reproduce the first Born term and, to order 1/p, the on-energy-shell part of the second Born term, for all momentum transfers. Furthermore, the Glauber approximation correctly gives the leading contribution (in powers of 1/p) to the on-energy-shell part of every term in Born series, whereas the Blankenbecler–Goldberger approximation fails to do this for Born terms beyond the second. However, since the comparison to the Born series shows that both approximations neglect contributions of order $1/p^2$, neither approximation, in the simple forms commonly used, is correct beyond terms of order 1/p. (auth)

40497 FOUR-POINT AND FIVE-POINT VENEZIANO-TYPE FORMULAS ON THE BASIS OF SPECTRAL REPRESENTATIONS. Nakanishi, Noboru (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 2: 288-92(15 Jul 1970).

The Veneziano-type formula for the scattering amplitude F(t,s) is derived in the form of an integral representation under the following assumptions: (1) F(t,s) has a fixed-s unsubtracted dispersion relation, and (2) for s fixed, F(t,s) has equidistant simple poles only. The crossing symmetry, F(t,s) = F(u,s), is seen to be nothing more than a relation specifying the characters of the weight function. It is demonstrated that the Veneziano-type integral representation is more convenient than the conventional Veneziano series. A Veneziano-type integral representation for the five-point function is derived under the following assumptions, which are natural extensions of the above two assumptions for the four-point function: (1′) The five-point function has a certain double-spectral representation, and (2′) it has equidistant simple poles only in the two relevant variables. (auth)

40498 SOME RESULTS IN NONRELATIVISTIC MANY-BODY SCATTERING THEORY. Riahi, F. (Aria-Mehr Univ., Tehran). Symp. Theor. Phys. Math.; 10: 69-83(1970).

From Symposia on Theoretical Physics and Mathematics, Madras, India. See CONF-690125.

A brief survey of the generalization of the Faddeev program to the case of N-body scattering ($N \geq 4$) is given. It is found that satisfactory results can be expected only for a certain class of short range forces and for an appropriate choice of variables. Asymptotic completeness does not yet follow from first principles. (J.F.P.)

40499 REGGE-POLE DUALITY AND UNIQUENESS OF THE GENERALIZED VENEZIANO AMPLITUDE. Sasaki, K.; Sugano, R. (Osaka City Univ.). Lett. Nuovo Cim.; 3: 776-80(13 Jun 1970).

An illustration is given, starting with the Regge-pole amplitude, of the duality for the Regge-poles–Regge-poles in each channel, by means of the sum of a parent and an infinite number of its daughter trajectories. Also the uniqueness of the Veneziano-type amplitude is proved for the Regge-pole theory by combining the s-, t-, and u-channel forms. This is demonstrated for spinless and equal-mass particles. It is noted that the generalization to unequal-mass particles is straightforward. (J.F.P.)

40500 DUALITY AND FINITE-ENERGY SUM RULES. Matveev, V. A.; Stoyanov, D. Ts.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 4: 11-17(Jul 1970). (In Russian).

The problem of the derivation of the Veneziano-type representation is considered on the basis of an auxiliary integral parametric representation of scattering amplitudes satisfying unsubtracted dispersion relations. (auth)

40501 FUNCTIONAL INTEGRATION METHOD AND EIKONAL APPROXIMATION FOR POTENTIAL SCATTERING AMPLITUDES. Pervushin, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 4: 22-32(Jul 1970). (In Russian).

By the functional integration method an asymptotic form of the potential scattering amplitude of high-energy particles is studied. The eikonal representation is found which differs from the known one. The connection of the obtained representation with those of eikonal in the quantum field model is discussed. (auth)

40502 PRODUCTION OF PROTONS AND LIGHT NUCLIDES IN THE INTERACTION (p + NUCLEUS) AT 600 MeV. Alard, Jean-Pierre (Univ., Clermont-Ferrand, France); Fargeix, Jacques; Fraysse, Lucien; Roche, Guy; Cordaillat, Andre; Cornago, Marcello; Sicre, Alain. Compt. Rend., Ser. B; 270: 1438-41(1 Jun 1970). (In French).

An experiment applicable to the study of the production of light nuclides and protons is described; the reactions considered are (p + nucleus) at 600 MeV for nuclei where $Z \geq 4$; the first experimental results concerning the reaction (p + aluminum) are compared with theoretical predictions. (auth) (France)

40503 TESTS OF DUALITY FOR FORWARD ELASTIC AMPLITUDES. Altarelli, G. (Rockefeller Univ., New York). Phys. Rev., D; 1: 3200-3(1 Jun 1970).

Some new quantitative tests of duality for elastic amplitudes at t = 0 are discussed. (auth)

40504 POMERANCHUK TERM IN THE DUAL QUARK MODEL. Freund, P. G. O. (Univ. of Chicago). Lett. Nuovo Cim.; 4: 147-52(25 Jul 1970).

The discussion of the Pomeranchuk term in the dual quark model covers charge conjugation properties of the Pomeranchuk singularity, the Pomeranchuk intercept $\alpha_P(0)$ and the slope α_P', and models in which the Pomeranchuk singularity bootstraps itself. (J.F.P.)

40505 SOME MATHEMATICAL ASPECTS OF MULTIPLE POLES IN THE OFF-SHELL SCATTERING AMPLITUDE. Ida, Masakuni (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 43: 808-29(Mar 1970).

An attempt at a general theory of the Bethe–Salpeter equation in a previous work is continued, with attention focussed on the problem of multiple poles in the off-shell scattering amplitude. Basic assumptions made in the previous work reduce the problem to that of multiple poles in the resolvent of a compact operator, which is hermitian analytic as an operator-valued function of P_4. Properties of compact operators are discussed on the basis of the Riesz–Schauder theory. Multiple poles are characteristic of non-normal operators, which are shown to be considerably different from hermitian operators in many points of physical importance. Several quantities useful for the understanding of multiple poles are introduced and their properties are investigated. Multiple poles in the resolvent of an analytic operator are studied as a limit of degeneracy of several simple poles. (auth)

Particle Accelerators

Refer also to abstracts 39196, 39383, 40302, 40577, and 40658.

40506 (BNL-14859) THE NEW LOW FREQUENCY RIPPLE CORRECTING SYSTEM FOR THE CONVERTED AGS. Carides, T.; Cottingham, J. G.; Eiseman, S. E.; Feltman, A. V. (Brookhaven National Lab., Upton, N. Y.). 6 May 1970. 41p. Dep. CFSTI.

The ripple correcting system for the converted AGS uses a combination of passive manually programmed, and dynamic systems to achieve the required regulation of magnet voltage during flat top. (auth)

40507 (CERN-Trans-69-18) KINETICS OF ELECTRON COOLING OF BEAMS IN HEAVY PARTICLE STORAGE DEVICES. Derbenev, Ya. S.; Skrinskii, A. N. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by B. Hodge (CERN, Geneva, Switzerland), from Preprint 255. 47p. Dep. CFSTI (U. S. Sales Only).

A study is made of the kinetic features of the method of electron

cooling of beams in heavy particle storage devices. Landau's integral of collisions for Coulomb interaction is used to obtain a kinetic equation for a beam of particles passing periodically through an accompanying stream of electrons. Apart from collisions with electrons, account is taken of scattering on coherent fluctuations (of a non-thermodynamic origin) of the space charge of the electron beam, and on atoms of residual gas. The final kinetic equation is the Fokker–Planck equation in action variables. In the second part, an investigation is made on this basis into the effect, on the kinetic process, of deviations in the electron stream from the state of thermodynamic equilibrium (in the accompanying system). A qualitative investigation is made into the dependence of the attenuation speed and of the stabilized values of angular and energy spread on the velocity distribution of electrons and on the spatial inhomogeneity of the electron beam in a radial direction. An evaluation is made of the permissible level of coherent noise in the electron stream. A solution is obtained for the kinetic equation in the region of small angles ($\theta_p < \theta_0$). An important theorem is established concerning the sum of decrements of the oscillations. An investigation is also made into the nature of the solution in the region of large amplitudes. (auth)

40508 (DESY–70/24) PLANS FOR THE STORAGE RING AND DETECTION APPARATUS AT DESY. Steffen, K. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jun 1970. 30p. Dep. CFSTI (U. S. Sales Only).

Topics include main features of the storage ring, dynamic control of the rf system, additional 50 MHz rf system, some features of beam optics, general experimental facilities, a 1.4 meter magnetic detector, and luminosity monitors. (W.H.K.)

40509 (NP–18316) ANNUAL REPORT, 1969. (Daresbury Nuclear Physics Lab. (England)). 115p. Dep. CFSTI (U. S. Sales Only).

Details are given of the organization of the laboratory and work carried out. The information is presented under the following headings: experimental physics; theoretical physics; physics apparatus and measurements; computing and electronics; electron synchrotron, operation and development; machine physics; electron synchrotron, new developments; engineering; administration; and a list of publications. (UK)

40510 (RHEL/R–198) NIMROD OPERATION AND DEVELOPMENT. Quarterly Report, January 1–March 31, 1970. Gray, D. E. (ed.) (Rutherford High Energy Lab., Chilton (England)). May 1970. 25p. Dep. CFSTI (U. S. Sales Only). UK 5s.

Details are given of Nimrod operation January 1 to March 31, 1970, and of the particle physics experimental program undertaken. An energy loss system, employing a new "thin-septum" magnet in Nimrod's third extracted proton beam, is described. Average intensities at the external target station of 9×10^{11} protons per pulse have been measured. A two-element personal dosimeter used on Nimrod is discussed. Some notes are given relating to water-vapor contamination of electrostatic separators and its reduction. (auth) (UK)

40511 (SLAC–PUB–739) HIGH-FIELD MAGNETS WITH AND WITHOUT FERROMAGNETIC RETURN YOKES. Brechna, H.; Perot, J. (Stanford Linear Accelerator Center, Calif.). Jun 1970. 42p. (CONF-700503–5). Dep. CFSTI.

From 3rd International Conference on Magnet Technology, Hamburg, Germany.

The main purpose of this paper is to illustrate the effect of ferromagnetic materials on field enhancement and field distribution in a useful magnet aperture. Also treated are the effects of perturbations due to manufacturing constraints. A selected number of magnet types was chosen, such as axially symmetric magnets, and higher order coils. The field distribution is calculated in the presence or absence of iron return yokes. The field values are obtained by using computer codes for variable permeability problems based on vector potential calculations. Computational results are compared to simplified first-order calculation methods utilizing uniform permeability distribution or infinite permeability in iron. To show the extent of perturbations due to coil manufacturing upon field or gradient homogeneity in beam transport magnets, a calculating method based on complex variables is used. Field or gradient distribution in the coil aperture, due to ideal current density distribution, is compared to flux densities or field gradients when the ideal coil configuration has been modified to a more practical shape. Current filaments (multipoles) are used to correct for field inhomogeneities. Computer calculations have their limitations due to convergence problems, size limitation, digitalization, and boundary effects. Specifically, if field homogeneity in the order of 10^{-5} over a certain experimental area is required, computational errors overshadow actual results due to the presence of iron with variable iron permeability or partial saturation. Based on a practical 8th-order coil, a computational method is illustrated, which overcomes this deficiency. (auth)

40512 (TRI–69–7) VACUUM SYSTEM MODEL STUDY FOR A 500 MeV H^- CYCLOTRON. Harwood, Vivienne J.; Yandon, J. C. (TRI–Univ. Meson Facility, Vancouver (British Columbia)). Dec 1969. 57p. Dep. CFSTI (U. S. Sales Only).

Using a 1 : 20 scale model of the TRIUMF vacuum chamber, simulation of chamber pumpdown performance with two different pumping system designs is described. Large trapped oil diffusion pumps and a 20°K cryopumping system, having auxiliary means for pumping hydrogen, are compared in relation to the design criterion of an equivalent nitrogen stripping cross-section pressure of 7×10^{-8} Torr within 15 hours of pumping. It is shown that the design criterion can be satisfied by the cryopumping system only, when a polyurethane main chamber seal is used; for this condition resonator bakeout is not required. This result will be valid for the full-scale machine, provided the outgassing rate of the resonator surfaces does not exceed that from the model resonators by more than a factor of 3. The component outgassing rates for stainless steel with different surface treatments are discussed. Data obtained prior to and following bakeout under vacuum to 80°C and 140°C, and air baking to 150°C, are considered. The gas loads from a variety of radiation-resistant elastomers are studied; different processing treatments for polyurethane receive particular attention. A comparison is made of the predicted pumpdown performance using measured outgassing rate data and the simulated performance in the model chamber. The effect of different chamber exposure conditions on pumpdown time is described; nitrogen venting has shown to be worthwhile only if the exposure time to moist air is limited. (auth)

40513 (TRI–70–1) THE CONCEPTUAL DESIGN OF THE BEAM TRANSPORT MAGNETS FOR BEAM LINE 1. Meads, P. F. Jr.; Oster, E. L.; Fredriksson, O. K.; McIlraith, T. E. (Brobeck (William M.) and Associates, Berkeley, Calif.). May 1970. 74p. Dep. CFSTI (U. S. Sales Only).

For TRI–Univ. Meson Facility, Vancouver (British Columbia).

The preliminary design of the beam transport system for TRIUMF beam line 1 is reviewed. Special attention is given to the portion of the transport system located between the combination magnet and the first target since it was felt that substantial cost savings could be realized by simplifications of this beam transport section. Four basic systems were studied, namely: (1) a system with three 30 deg bending magnets where the middle magnet creates a reverse bend (reverse bend system); (2) a modified achromatic system with three or four identical gradient bending magnets (gradient-magnet bend system); (3) a modified-achromatic system with two 15 deg bending magnets (two-magnet bend system); and (4) (a) a dispersion-correcting system with one 30 deg bending magnet having wedge-shaped poles (single-magnet bend system/wedge magnet), and (b) a dispersion-correcting system with one 30 deg bending magnet having rectangular poles (single-magnet bend system/rectangular magnet). Based on the results of the study work done, it is recommended that a dispersion-correcting beam transport system consisting of eight quadrupole magnets, a combination magnet and a 30 deg bending magnet, both with square pole tip edges, be used in beam line 1. (auth)

40514 (UCRL–18882) MAGNETIC FIELD CALCULATIONS FOR THE 184-INCH SYNCHROCYCLOTRON. Paul, A. C.; Colonias, J. S. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb 1970. Contract W-7405-eng-48. 19p. Dep. CFSTI.

Experience with the use of a computer program to calculate the magnetic field change produced by a change in the coil excitation of the Berkeley 184-inch synchrocyclotron is described. One of the interesting aspects of these calculations is the simulation of the magnet with a cylindrical pole face and a rectangular return yoke. The raw computed magnetic field compares to the azimuthally averaged measured field at the same excitation to within 1%. A subtraction technique is used to cancel integration and systematic model errors and yields a calculated magnetic field that compares to within 0.1% with the measured fields at different excitations. The calculations include the effects of the plate construction (stacking factor) of the magnet and assume median-plane symmetry, but do not include the small effects produced by the main-coil current symmetry shunts and nonuniform current distribution, although these could have been included. (auth)

40515 (UCRL–19414) ON-LINE CALCULATION OF BEAM TRANSPORT SYSTEMS TO FIRST AND SECOND ORDER. Colonias, John S.; Paul, Arthur C. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr 1970. Contract W-7405-eng-48. 23p. (CONF-700503–6). Dep. CFSTI.

From 3rd International Conference on Magnet Technology, Hamburg, Germany.

This paper describes the application of on-line techniques to the design of beam transport systems. We introduce program TRANSPORT which allows the user to design such systems interactively with a computer through a display console, light pen, and teletype. The program is capable of providing solutions to first and second order for systems containing a wide variety of beam transforming elements. The versatility of the program is evidenced by the interacting process which permits the experimenter to: 1. view the entire system (or part of it) on a cathode ray tube; 2. observe the beam envelope (or trace rays); 3. observe the transfer matrix and phase space ellipse (or polygon) at any point of the trajectory; 4. change parameters and computer optimize; and 5. perform second order ray tracing. (auth)

40516 (UCRL-19720) BEVATRON OPERATION AND DEVELOPMENT. 64. October–December 1969. Crebbin, Kenneth C.; Frias, Robert; Grunder, Hermann A. (California Univ., Berkeley. Lawrence Radiation Lab.). 6 Mar 1970. Contract W-7405-eng-48. 9p. Dep. CFSTI.

The Bevatron provided beam to 18 experiments this quarter and during two months of operation accelerated 2.4×10^{18} protons. Eight experiments were completed. Resonant extraction studies are reported, and the plans to make the system operational are discussed. Also, the new computer control system for the main motor generators is discussed. (auth)

40517 NEW USES FOR LOW-ENERGY ACCELERATORS. Washington, D. C.; National Academy of Sciences (1968). 182p.

Applications of low-energy accelerators to the fields of nuclear astrophysics and solid-state and atomic physics are discussed. The energies considered are at a maximum of 6 MeV. Some of the topics discussed are: thermonuclear reactions, beam–foil spectroscopy, atomic lifetime measurements, penetration and losses in solid targets, channeling and ion implantation, and interactions of nuclear moments with solid-state environments. (M.O.W.)

40518 TRANSVERSE INSTABILITY OF AN INTENSIVE ELECTRON BEAM IN A BETATRON. Moskalev, V. A. (Tomsk Polytechnical Inst., USSR). Nucl. Instrum. Methods; 84: 69-73(1970).

Experimental data on transversal instability of an intensive electron beam in high current betatrons are described. (auth)

40519 THIRD ORDER ABERRATIONS FOR ION ORBITS IN STATIC MAGNETIC FIELDS WITH MID-PLANE SYMMETRY. Tautz, M. F. (Univ. of Victoria, B. C.). Nucl. Instrum. Methods; 84: 29-36(1970).

Trajectory equations for charged particles in static magnetic fields are derived. The equations are non-linear but approximate solutions expressed in terms of Green's function integrals may be obtained for the case in which the field contains a symmetry midplane. Formulas are given for the systematic calculation of trajectories accurate to third order. (auth)

40520 THE PSEUDO-SAMPLE METHOD: AN EXPERIMENTAL PROCEDURE FOR SAMPLE-HOLDER CORRECTIONS IN NEUTRON SCATTERING. Price, D. L. (Argonne National Lab., Ill. Brookhaven National Lab., Upton, N. Y.); Meister, H. Nucl. Instrum. Methods; 84: 61-6(1970).

A procedure is described for correcting neutron scattering data in cases where the measurement is significantly affected by the scattering and absorption of the sample-holder. The basic idea is to compose a pseudo-sample which approaches the scattering and absorption properties of the real sample, but which can be measured both with and without the sample-holder under the experimental conditions of the real sample runs. From these measurements one can deduce rather accurate corrections for the scattering data from the real sample. The application of this method to a recent measurement of the scattering from incoherent CuNi is discussed, followed by results of an experimental verification of the procedure. (auth)

40521 SOLUTION OF BEAM TRANSPORT PROBLEMS WITH A HYBRID ANALOG COMPUTER. Brand, K. (Ruhr-Univ., Bochum, Ger.). Nucl. Instrum. Methods; 84: 21-3 (1970). (In German).

Fast beam transport calculations to first order are discussed using a small desk-top analogue hybrid computer and a storage oscilloscope. (auth)

40522 CALCULATION OF THE GEOMETRY OF MAGNETIC CHANNELS FOR SYNCHROCYCLOTRONS AND CYCLOTRONS. Carbonel, B.; Danilov, V. I.; Ianovici, M.; Polferov, E. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 84: 144-46(1970).

A programme written in FORTRAN-63 for the calculation of the geometrical parameters of magnetic extracting or focusing channels for synchrocyclotrons or cyclotrons has been set up. The number and parameters of correction shims are also computed by the programme. (auth)

40523 CROSSING OF AN INCOHERENT INTEGRAL RESONANCE IN THE ELECTRON RING ACCELERATOR. Pellegrini, C.; Sessler, A. M. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 84: 109-16(1970).

In one mode of operation of an electron ring accelerator (ERA), at the end of compression, rings are slowly moved through the radial integral betatron resonance $Q_r = 1$. Although the coherent radial oscillation frequency of the ring as a whole remains below unity, the oscillation frequencies of individual electrons are (incoherently) caused to pass through the resonance because of the additional focusing from ions trapped in the ring. The effect of field errors on ring major and minor radii is evaluated, theoretically, for the cases in which the spread in the square of the electron oscillation frequency (Δ^2) is (a) much smaller and (b) much larger than the contribution to the square of the oscillation frequency from the ions (Λ^2). It is shown that for the ERA, where case (a) applies, the increase in ring minor dimensions, for given field errors and rate of resonance crossing, is less than in case (b) by a factor of $(\Delta/\Lambda)^2$. Numerical examples show that the degradation of ring quality in case (b) should, with suitable attention to the design and construction of the ERA apparatus, be acceptably small. (auth)

40524 RESONANT HIGH-FREQUENCY DISCHARGE IN HIGH-CURRENT RESONATORS FOR ELECTRON ACCELERATORS. Iremashvili, D. V.; Leont'ev, N. I. Zh. Tekh. Fiz.; 40: 820-4(Apr 1970). (In Russian).

The results of the experimental investigation of the resonant high-frequency discharge, developing in quarterwave coaxial resonators of high-current electron accelerators, are reported. The investigations were carried out during constant and collision excitation of the accelerating structure, operating at a frequency of 6.3 MHz and having unloaded, ~7000. It was shown that the Q of the accelerating structure does not have constant magnitude and strongly depends on the level of the high-frequency voltage and the pressure in the working volume. The areas of the formation of the resonant high-frequency discharge and its dynamics in the process of voltage increase in the resonator were investigated. It was established that the resonant high-frequency discharge forms in the areas of the accelerating gap where production of the frequencies in MHz along the length of the gap in cm does not exceed 50 MHz·cm. The Q of the resonator in this case is 20 to 30 at a vacuum of 2×10^{-6} torr. The scheme of the collision excitation of the resonator during oscillating discharge of the capacity in the coupling loop makes it possible to overcome the threshold of resonant high-frequency discharge and can be used for pre-excitation of the generator–resonator system operating in a self-oscillating regime. (tr-auth)

40525 CALCULATIONS ON WAVEGUIDES WITH CONSTANT VOLTAGE OF ACCELERATING FIELD. Val'dner, O. A.; Zverev, B. V.; Sobenin, N. P. Zh. Tekh. Fiz.; 40: 814-19(Apr 1970). (In Russian).

Simple formulas and graphs for the calculation of the geometric dimensions and other important characteristics of electron linear accelerators, having diaphragm waveguides with constant gradients of the accelerating field during nominal current load are presented. The results of all relations were based on the fact that the principle of the change of the group velocity along the axis of such a diaphragm waveguide can be represented with sufficient practical precision by linear functions. It is shown that the results of the calculations with the formulas and graphs presented differ from precise calculations with efficiency balance equations by no more than ±10%. Therefore, the method proposed is especially suitable for comparative evaluations of different variants of diaphragm waveguides with constant gradients. (tr-auth)

40526 SOME PROPERTIES OF RELATIVISTIC PLASMA RINGS. Kegel, W. H. (Institut fuer Plasmaphysik, Munich). Plasma Phys.; 12: 105-21(Feb 1970).

Interest in plasma rings consisting of electrons with a relativistic mean velocity and fewer ions with a low mean velocity has been created by the project of the electron ring accelerator (ERA). Some necessary conditions for such systems to be in equilibrium are derived. (UK)

40527 LAMPF: A MESON FACTORY IN THE MAKING. Rosen, Louis (Los Alamos Scientific Lab., N. Mex.). Nucl. News; 13: No. 8, 61-4(Aug 1970).

The Los Alamos Meson Physics Facility is described. The drift-tube accelerator, funding and construction status, research programs, and practical applications are discussed. (W.H.K.)

40528 ELECTRON ACCELERATORS FOR HIGH VOLTAGE ELECTRON MICROSCOPES. Ogilvie, R. E. (Massachusetts Inst. of Tech., Cambridge). Micron; 1: 256-62(Dec 1969).

1st National Conference on Current Developments in High Voltage Electron Microscopy, Monroeville, Pa. See CONF-690643.

The achievement of better resolution by HVEM with higher voltages is discussed. This enhancement depends on extremely stable power supplies, the design, construction and stabilization of which are discussed in the seven papers of this session. (i) Design problems of electron accelerators for high voltage electron microscopes. Reihold, G. (E. Haefely, Basel, Switzerland). (ii) Regulated DC power supply for high voltage electron microscopes. Trumpy, K., Reinhold, G., Savary, J. L. (E. Haefely, Basel, Switzerland). After reviewing earlier high voltage techniques and the modern trend toward the compact pressurized accelerators the twin-tank design is described. (iii) New type high voltage generator. Ohta, S., Watanabe, M., Nakamura, O. (Japan Electron Optics Laboratory, Tokyo). A new type of center-tapped C-W circuit is reported which has greater electrical and mechanical symmetry as well as reduced stray capacitance. The influence of prebreakdown current, elimination of mechanical vibration, minimization of X-ray production and suppression of discharge surges are discussed. (iv) The insulating core transformer power supply and electron accelerator for high voltage electron microscopes. Stillicorn, B. (High Voltage Engineering Corp., Burlington, Mass.). The insulating core transformer which consists of two pressure tanks, one containing the power supply and the other the electron accelerating tube is described in detail. (v) Oil immersed high stability power supplies in the 200-600 kV range. Strojnik, A. (Cornell Univ.) The power supply described was built using cheap, safe and reliable mineral oil and plexiglass. The 200 kV supply used three independent resistor chains, one for current measurement and two for regulation. (vi) A 1 MeV electron microscope source. Donhowe, J. M. (Univ. of Wisconsin). An electron beam injection charging system which employs two Van de Graaff type accelerators is described. (vii) 1 MeV electron accelerator of the twin tank design. Williams, J. L. (Associated Electrical Industries, Harlow, Eng.). Reinhold, G. The requirements of the twin-tank high voltage unit described in the first paper are reported. (auth) (UK)

40529 PARTIALLY AUTOMATIZED OPERATION OF A VAN DE GRAAFF ACCELERATOR. Richter, E.; Turuc, S. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 13: 122-4(Apr 1970). (In German).

For simplifying the operation of a 2 MeV Van de Graaff accelerator, the device has been subjected to a partial automatization. Control circuits necessary for this purpose as well as their principle of action are described from the signal flow chart. The method of determining stable operational conditions is given. (auth)

40530 THREE-SECTOR FOCUSING MAGNETIC PRISMS WITH r^{-1} FIELD. PART I. GENERAL CONSIDERATIONS AND METHODS. Fedoseev, E. P.; Malov, A. F.; Suzdalev, V. A.; Zolotarev, V. S. (Kurchatov Inst. of Nuclear Energy, Moscow). Kernenergie; 13: 127-32(Apr 1970). (In Russian).

A new kind of axial-symmetric-type focusing magnetic prism with a three-sector field consisting of homogeneous fields closely adjacent at the boundaries and an inhomogeneous field between them is proposed. Systems of such kind have the advantage of both the homogeneous and the inhomogeneous field. Basic ion-optical relations for the three-sector magnetic prisms with r^{-1} field are derived. (auth)

40531 TANDEM VAN DE GRAAFF ACCELERATORS. Rose, Peter H.; Wittkower, Andrew B. Sci. Amer.; 223: No. 2, 24-33(Aug 1970).

A historical review of the development of the tandem Van de Graaff accelerator is given, and the basic theory of operation is described. (W.H.K.)

40532 THEORETICAL POSSIBILITIES OF A SOLENOID AS MASS FILTER. Kubicek, P. (Inst. of Mining and Metallurgy, Ostrava, Czech.). Czech. J. Phys.; 20: 475-86(1970).

The paper deals with equations of motion of ions in a time-dependent magnetic field of a solenoid. These lead to a Hill equation approximated by a Mathieu equation. The instability of solutions of these equations in certain regions implies a theoretical possibility of filtering ion beams according to masses. (auth)

40533 INTRODUCTION TO A LINEAR THEORY OF ACCELERATORS. NOTE III. CALCULATION OF THE HORIZONTAL DAMPING COEFFICIENTS IN THE STRONG-FOCUSING CASE. Uccelli, Fabio (Univ., Pisa, Italy). Ric. Sci.; 39: 489-97 (Jul-Sep 1969).

The horizontal motion of particles and the damping of betatron and synchrotron oscillations in the strong-focusing case are studied by means of a perturbation method. (auth)

40534 INTRODUCTION TO A LINEAR THEORY OF ACCELERATORS. NOTE IV. CALCULATION OF THE HORIZONTAL DISPERIONSION OF THE BEAM DUE TO THE FLUCTUATION OF THE RADIATION. Uccelli, Fabio (Univ., Pisa, Italy). Ric. Sci.; 39: 498-500(Jul-Sep 1969).

The influence of the fluctuation of the radiation of the particles on the horizontal dimensions of the beams in accelerators is studied. (auth)

40535 12 MeV MICROTRON USED AS INJECTOR OF THE FRASCATI ELECTRON-SYNCHROTRON. Bizzarri, U.; Vignati, A. (CNEN, Frascati, Italy). Nuovo Cim.; 68A: 513-45(1 Aug 1970).

The 12 MeV and 50 mA peak current beam microtron used as injector of the Frascati electron-synchrotron is described. The scheme and the realization of the accelerating cavity, the magnetic field, the beam-extraction system and the cathode technology are discussed. (auth)

40536 ORELA DATA ACQUISITION INTO GREATER THAN 10^5 CHANNELS THROUGH A PRIORITY MULTIPLEXER OPERATING ON A DIRECT MEMORY ACCESS AND A PROGRAM CONTROLLED DEVICE INTERFACE. Reynolds, J. W. (Oak Ridge National Lab., Tenn.); Betz, N. A.; McCully, D. A. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 383-9(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The Oak Ridge Electron Linear Accelerator (ORELA) facility includes a linear accelerator and a series of computers for real-time data acquisition and on-line analysis of the acquired data. The unique features of the data acquisition computers are the following: a word-addressed, fixed-head disk; a direct-memory access, four-channel priority multiplexer capable of a peak data rate of 25,000 events/sec per channel; and a program-controlled, subaddressed device interface. Operation of the word-addressed, fixed-head disk through software and hardware control allows the experimental events to determine which channels are to have their contents read into the core memory from the disk for updating, with a resulting theoretical maximum average data rate of 11,000 events/sec. Trade-offs for future systems are possible between the hardware and software. Operation of the priority multiplexer is described briefly. A modified, TMC, 4096-channel time-of-flight analyzer allows control from the computer through the multiplexer. A pulse generating unit, mounted in a triple-width NIM module, operates through one channel of the program-controlled device interface to control a TMC time-of-flight analyzer and a sample changer. The sample changer operates in a feedback loop that is controlled by a computer program. (auth)

40537 ANALOG DATA BREAK INTERFACE. Henness, J. M. (Princeton–Pennsylvania Accelerator, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 423-27(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

This paper describes the interface used for online control of the Princeton-Pennsylvania Accelerator with a PDP-9. The paper is organized into four sections. The first section is concerned with the specifications for the equipment. The requirements are unique because of the cyclic nature of the synchrotron. Section two discusses various I/O techniques and the design compromises they require. The third section deals with the concept of an analog data break interface. The last section is a summary of existing and planned hardware. (auth)

40538 A METHOD FOR INCREASING THE RADIATION INTENSITY OF A BETATRON OR SYNCHROTRON. Pikulik, Lubomir (to Ceskoslovenska Akademie VED). British Patent 1,199,636. 22 Jul 1970. Priority date 16 Nov 1966, Czechoslovakia.

A method for increasing the radiation intensity of an accelerator of the betatron or synchrotron type, which effects and improves the conditions of the capturing process at otherwise optimum operation, is outlined. By suitably changing the geometry of injection, i.e., of changing the injection angle to the equilibrium path in the effective interval of the injecting pulse, the conditions of capturing the electrons onto stable paths are affected so that the captured charge and, consequently, also the radiation intensity, grows considerably. (C.E.S.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 39319, 40191, 40520, and 40620.

40539 (IN–1317, pp 65–8) NEUTRON INTERACTIONS WITH ATOMS. (Idaho Nuclear Corp., Idaho Falls).

Experimental scattering low data for zirconium, which has been evaluated for the ENDF/A file, is presented. (J.W.R.)

40540 (RT/FI–(70)6) ENDOMORPHISM OF A LEBESGUE SPACE Lp(p > 3) IN A THREE-DIMENSIONAL PROBLEM OF NEUTRON TRANSPORT THEORY. Boffi, V. C.; Molinari, V. G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 11 Dec 1969. 47p. Dep. CFSTI (U. S. Sales Only).

An endomorphism of a Lebesgue space $Lp(\Delta_3)$ with $3 < p < \infty$, where Δ_3 is an infinite three-dimensional domain, is discussed in some detail. Such an endomorphism occurs in the study of a linear integral nonsingular equation. This equation governs the three-dimensional Fourier transform of the total flux of monoenergetic neutrons, which diffuse from an isotropic pointwise source located at the centre of a parallelepiped of moderator material. (auth)

40541 (WAPD-TM-959) ON THE USE OF SPACE-SYNTHESIS WITH ENERGY GROUP COLLAPSING. (LWBR Development Program). Yasinsky, J. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr 1970. Contract AT-11-1-GEN-14. 23p. Dep. CFSTI.

Some numerical studies are described aimed at determining the accuracy and reliability of several collapsed-group synthesis methods for few-group neutron diffusion problems. The methods investigated include the weight function scaling approach where the energy group ratios of the trial functions are scaled before they are used as weight functions. Also included are comparisons with a collapsed group synthesis approach which uses only one weight function for each subset of collapsed energy groups. (auth)

40542 TIME EIGENVALUES AND ANISOTROPIC DISTURBANCES IN THE PULSED NEUTRON EXPERIMENT. Williams, M. M. R. (London Univ.). J. Nucl. Energy; 24: 97-100(Apr 1970).

Earlier work on neutron thermalization and the kinetic theory of gases is discussed, and used to establish the existence of discrete relaxation times for an anisotropic neutron pulse in an infinite, uniform moderator. In contrast to the case of isotropic disturbances where, for a monatomic gas, there are an infinite number of discrete eigenvalues, it is found that for Legendre components $l \geq 2$ the discrete spectrum, for all mass numbers A, is empty. For A > 4, even the l = 1 equation has no discrete eigenvalues. (auth) (UK)

40543 ENERGY DISTRIBUTION OF ANTIMONY–BERYLLIUM PHOTONEUTRONS. Lalovic, M.; Werle, H. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Energy; 24: 123-32(Jun 1970).

The proton-recoil proportional counting method with gamma-neutron discrimination was used to measure the neutron spectrum of an antimony-beryllium source located in a lead gamma-shielding. Since the variations in the neutron spectrum caused by the lead and the source material are small, the photoneutron spectrum could be determined with good accuracy by a Monte Carlo neutron transport code. The distribution of photoneutrons from the primary group had a width of 3.5 ± 1.5 keV and an average energy of 26.0 ± 1.3 keV. In addition to this primary neutron group a second neutron group at 363 ± 15 keV and with an intensity of 5.1 ± 1 percent as compared with the primary group could be established. The neutron spectra for a series of representative source geometries are calculated and compared with previously published results. (auth) (UK)

40544 PROMPT NEUTRON PROBABILITY DISTRIBUTIONS IN AN INFINITE HOMOGENEOUS MEDIUM DUE TO A UNIFORMLY DISTRIBUTED SOURCE. Smith, P. R. (Queen Mary Coll., London). J. Nucl. Energy; 24: 164-7(Jun 1970).

The properties of a neutron probability generating function due to a uniform neutron source and its relationship with a single neutron generating function are discussed. Approximate expressions are defined for the probability generating function, which may be used for rapid, accurate evaluation of neutron probability distribution for subcritical systems at late times. (UK)

40545 PROBABILITY DISTRIBUTION OF PROMPT NEUTRONS IN AN INFINITE HOMOGENEOUS MULTIPLYING MEDIUM. Smith, P. R. (Queen Mary Coll., London). J. Nucl. Energy; 24: 159-63(Jun 1970).

The properties of a single neutron probability generating function are discussed. An approximate solution is presented which is shown to be valid for subcritical systems at late times. (UK)

40546 STUDY OF NEUTRON TRANSMISSION THROUGH POLYCRYSTALLINE TILTERS BY A MONTE CARLO METHOD. DeMichelis, F.; Ferrero, G.; Vallana, F. (Politecnico, Turin). Nucl. Instrum. Methods; 83: 283-7(1970).

The transmission of thermal neutrons through a polycrystalline filter is studied using a Monte Carlo method. The energy distribution of emerging neutrons and the optimal filter length in order to have a maximum purity without an excessive absorption have been calculated. Numerical evaluations for beryllium filters are reported. (auth)

40547 ASYMMETRIES IN THE SCATTERING OF X-RAYS AND NEUTRONS BY CRYSTALS. Cowley, R. A.; Buyers, W. J. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Phys., C (London); 2: 2262-72(Dec 1969).

The theory of the scattering of x-rays and neutrons by an anharmonic crystal is discussed, with particular reference to the interference between the one- and two-phonon scattering. This interference gives rise to an extra contribution to the intensity of the scattered x-rays and to a change in both the intensity and the shape of the one-phonon part of the neutron scattering cross section. Detailed numerical calculations are performed for alkali halides. The results show that the asymmetries found recently in the scattering of x-rays by alkali halides are of this origin. In the case of neutron scattering the change in shape of the one-phonon peaks is so small that it is probably unobservable under experimental conditions available at present, but the change in the intensity should be observable. (auth) (UK)

40548 MEASUREMENT OF SECOND-ORDER CONTAMINATION IN DIFFRACTED NEUTRON BEAMS BY AN ABSORBING FOIL TECHNIQUE. Alston, W. C. H. (London Univ). Nucl. Instrum. Methods; 84: 153-5(1970).

The second order contamination present in the diffracted beam from a neutron monochromating crystal [Be (0002) planes] is measured over the energy range 0.065 to 0.3 eV. Emphasis is placed on this variation over competition dips. (auth)

40549 ELECTROMAGNETIC ION BEAM SHUTTER. Szalay, A.; Dombi, I. (ATOMKI, Debrecen, Hungary). Nucl. Instrum. Methods; 84: 149-50(1970).

A mechanical ion beam shutter is described, which is operated by electromagnets from outside of vacuum. Its quick operation (0.07 s) and reliability demonstrated its usefulness in neutron activation experiments connected with a 300 kV and 300 μA D beam of a neutron generator. (auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 40685 and 40700–40703.

40550 (WASH–1136) REPORTS TO THE AEC NUCLEAR CROSS SECTIONS ADVISORY COMMITTEE MEETING AT RICE UNIVERSITY, HOUSTON, TEXAS, SEPTEMBER 18–19, 1969. Chrien, R. E. (comp.) (Nuclear Cross Sections Advisory Committee (AEC)). 281p. (EANDC–122–U; INDC–14–U; CONF-690937). Dep. CFSTI.

ALUMINUM-27—neutron reactions (n,α) at 13.6 to 14.8 MeV, excitation function for, (E)
—neutron reactions at 4, 6, and 7.5 MeV, γ production cross sections for, (E)
ARSENIC-75—neutron reactions (n,α) at 13.6 to 14.8 MeV, excitation function for, (E)
BERYLLIUM-9—neutron reactions at 14.8 MeV, γ production cross sections for
BORON-10—neutron absorption cross section for, thermal, (E)
CALIFORNIUM-252—fission of, γ-ray yields from spontaneous, (E)
—fission of, delayed γ yield from spontaneous, (E)
CARBON—neutron total cross section at 0.1 to 1.5 MeV, (E)
—neutron reaction at 5 and 14.8 MeV, γ production cross sections for, (E)
CARBON-12—alpha reactions (α,γ) at 1.8 to 3.2 MeV, cross sections for, (E)

CHROMIUM—neutron reaction at 5 and 14.8 MeV, γ production cross sections for, (E)
CURIUM-244—neutron fission at 20 Ev to 2 MeV, cross section for, (E)
HELIUM-3—neutron capture up to 8 MeV, cross section for, (E)
HOLMIUM-165—neutron capture at resonance energies, γ-ray intensities and resonance spin assignments for, (E)
HYDROGEN—neutron cross section at 1.5 to 15 MeV, (E)
INDIUM-113—neutron reactions at 14 MeV, activation cross sections for, (E)
INDIUM-115—neutron reactions at 14 MeV, activation cross sections for, (E)
IRIDIUM-191—neutron reactions at 14 MeV, activation cross sections for, (E)
IRIDIUM-193—neutron reactions at 14 MeV, activation cross sections for, (E)
LEAD-207—photon reactions (γ,n) with, cross section for threshold, (E)
LEAD-208—photon reactions (γ,n) with, cross section for threshold, (E)
LITHIUM-6—neutron absorption cross section for, thermal, (E)
LUTETIUM-175—neutron capture at resonance energies, γ spectra from, (E)
LUTETIUM-176—energy level scheme for, (E)
NEODYMIUM-142—nuclear charge distribution of, (E)
—energy levels from electron inelastic scattering, transition probabilities for, (E)
NEODYMIUM-146—nuclear charge distribution of, (E)
—energy levels from electron inelastic scattering, transition probabilities for, (E)
NEODYMIUM-150—nuclear charge distribution of, (E)
—energy levels from electron inelastic scattering, transition probabilities for, (E)
—electron inelastic scattering at 60 MeV, electron spectra from, (E)
NICKEL—neutron reactions at 4 MeV, γ production cross sections for, (E)
NIOBIUM-93—neutron reactions at 0.7 to 1.9 MeV, γ production cross sections for, (E)
NITROGEN-14—photon reactions (γ,n) at 12 and 25 MeV, differential cross sections for, (E)
PLUTONIUM-239—neutron fission at 40 to 100 eV, resonance parameters for, (E/T)
—neutron capture at resonance energies, γ spectra from, (E)
—neutron fission of, γ-ray yields from thermal, (E)
PLUTONIUM-241—neutron fission at 0.5 to 2 MeV, cross-section calculation using Hauser–Feshbach theory and (t,pf) data, (T)
PLUTONIUM-242—neutron fission at 0.5 to 2 MeV, cross-section calculation using Hauser–Feshbach theory and (t,pf) data, (T)
THORIUM-231—neutron fission at 0.5 to 2 MeV, cross-section calculation using Hauser–Feshbach theory and (t,pf) data, (T)
THORIUM-233—neutron fission at 0.5 to 2 MeV, cross-section calculation using Hauser–Feshbach theory and (t,pf) data, (T)
THULIUM-169—neutron capture at resonance energies, γ-ray intensities and resonance spin assignments for, (E)
TUNGSTEN—neutron scattering at 1 MeV, x-ray and low-energy γ spectra from, (E)
—neutron reactions at 0.3 and 1.0 MeV, γ production cross sections for, (E)
—neutron reactions at 5 MeV, γ production cross sections for, (E)
URANIUM-235—neutron fission of, γ-ray yields from thermal, (E)
—neutron fission at 0.5 to 2 MeV, cross-section calculation using Hauser–Feshbach theory and (t,pf) data, (T)
—neutron fission of, prompt γ spectra from thermal, (E)
URANIUM-237—neutron fission at 0.5 to 2 MeV, cross-section calculation using Hauser–Feshbach theory and (t,pf) data, (T)
URANIUM-238—neutron capture up to 9 eV, γ spectra from, (E)
—neutron scattering at 1 MeV, x-ray and low-energy γ spectra from, (E)
—neutron reactions at 0.3 and 1.0 MeV, γ production cross sections for, (E)
URANIUM-239—neutron fission at 0.5 to 2 MeV, cross-section calculation using Hauser–Feshbach theory and (t,pf) data, (T)
ZIRCONIUM—neutron reactions at 4 MeV, γ production cross sections for, (E) (J.W.R.)

40551 HARTREE–FOCK CALCULATIONS WITH A FOUR-BODY INTERACTION. Boffi, S.; Campagnoli, G. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy). Nuovo Cim.; 67A: 584-94(21 Jun 1970).

Hartree–Fock calculations for ^{4}He and ^{16}O were performed using a phenomenological nuclear interaction consisting of a two-body semi-realistic potential together with a four-body surface contact interaction. Zeroth-order effects of the four-body potential on binding energies, r.m.s. radii, mass distributions and charge form factors were investigated. (auth)

40552 NUCLEON–NUCLEON SCATTERING PARAMETERS FROM FINAL-STATE INTERACTIONS. Gross, E. E. (Oak Ridge National Lab., Tenn.); Hungerford, E. V.; Malanify, J. J.; Woods, R. Phys. Rev., C; 1: 1365-76(Apr 1970).

The energy spectra of α particles are measured at 5° lab for the reaction ^{3}He(^{3}He, α) pp using a 20-MeV ^{3}He beam; at 5° and 8° lab for the reaction ^{3}He(t,α) np; and at 5°, 8°, and 10° lab for the reaction ^{3}H(t,α) nn using a 22-MeV triton beam. The 5° lab spectra corresponding to low relative energy in the unobserved two-nucleon system are well fitted with Watson–Migdal final-state-interaction theory for the following scattering lengths: $a_{pp} = -7.52 \pm 0.22$ F, $a_{np} = -21.5 \pm 2.3$ F, and $a_{nn} = -16.96 \pm 0.51$ F. Analyzing the change-symmetric reactions with the comparison method and using the accepted value for a_{pp}, $a_{nn} = -18.11 \pm 0.75$ F. When compared with Coulomb-corrected values of a_{pp}, these values of a_{nn} imply that nucleon–nucleon forces are charge-symmetric to better than 1%. In obtaining the scattering lengths, the effective range is fixed at $r_0 = 2.84$ F. Allowing both the effective range and scattering length to vary in the fitting procedure for the n–n final-state data, $a_{nn} = -17.4 \pm 1.8$ F and $(r_0)_{nn} = 2.4 \pm 1.5$ F. If the n–n scattering length is fixed at the values −17.0 F, the data determine the effective range to be $(r_0)_{nn} = 2.75 \pm 0.35$ F. (auth)

40553 VENEZIANO AMPLITUDE FOR πN SCATTERING. Joshi, G. C.; Pagnamenta, Antonio (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., D; 1: 3117-23 (1 Jun 1970).

A crossing-symmetric Regge-behaved amplitude for πN scattering is constructed with a minimum number of Veneziano terms from ρ, ρ', P′, and P″ trajectories in the t channel and N_α, N_γ, and Δ_δ trajectories in the s and u channels. The parameters are determined from low-energy πN resonances, isospin selection rules, and ρ universality. The model fits the high-energy charge-exchange differential cross sections in the forward direction, and also predicts polarization in reasonable agreement with experimental values. The resulting backward elastic differential cross sections are discussed. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 39221, 40550, 40551, 40582, and 40700–40703.

40554 (AD–703259) THE PRODUCTION OF ^{7}Be, ^{11}C, ^{13}N, OR ^{15}O FROM CARBON, NITROGEN, AND OXYGEN BY 87-MeV ELECTRONS. Higgins, Robert Martin (Naval Postgraduate School, Monterey, Calif.). Oct 1969. 44p. CFSTI.

Thesis.

Targets of graphite, melamine, and water were bombarded with 87-MeV electrons from the Naval Postgraduate School linear accelerator in order to investigate the production of the unstable nuclei ^{7}Be, ^{11}C, ^{13}N, and ^{15}O from the electromagnetic disintegration of carbon, nitrogen, and oxygen. The ^{7}Be fragments were detected by observing the 477-keV gamma ray from the daughter nucleus ^{7}Li. The other disintegration fragments were detected by the annihilation of the emitted positrons which produced 511-keV photons. A copper radiator was introduced in one-half of the bombardments of each type of nucleus in order to separate the electron and photon effects. (auth) (USGRDR)

40555 (CEA-CONF-1498) STUDY OF THE DECAY OF ^{12}C INTO 3 α. Giorni, A.; Kong A Siou, D. (Grenoble Univ. (France). Institut des Sciences Nucléaires. Commissariat à l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucléaires). [1970]. 8p. (In French). (CONF-700313-2). Dep. CFSTI (U. S. Sales Only).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France.

The reaction $^{11}B + p \rightarrow {}^{12}C \rightarrow 3\alpha$ was studied for proton energies of 0.163, 0.68, 1.4, and 2 MeV. The results were compared with a calculation where the reaction amplitude takes into account the formation of ^{12}C and the α–α interaction in the final state. The mechanism of the sequential reaction with a single

$\alpha-\alpha$ interaction in the final state leads to a satisfactory explanation of experimental spectra. However, the results relating to the 0^+ resonance of ^{12}C at $E_p = 2$ MeV are not as good because, in this area, the contribution of the close 1^- and 3^- levels of ^{12}C cannot be neglected. (auth) (France)

40556 (IJS–572) TABLES OF TOTAL ABSORPTION CROSS SECTIONS FOR PHOTONS OF ENERGY BETWEEN 10 AND 30 MeV IN Be, C, N_2H_4, H_2O, HF, Si AND Ca. Bezic, N.; Brajnik, D.; Jamnik, D.; Kernel, G.; Miklavzic, U. (Institut Jozef Stefan, Ljubljana (Yugoslavia)). Nov 1969. 23p. Dep. CFSTI (U. S. Sales Only).

Measured cross sections for absorption of photons in some light elements are presented. The attenuation coefficients were determined with an experimental set-up consisting of a 33-MeV betatron as a gamma-ray source, the absorber, and a four-channel Compton spectrometer. The spectrometers had a resolution of about 2%, and the experimental values within energy intervals of less than 100 keV were normally joined into one value. No correction for the spectrometer response was applied to the data. (auth)

40557 (NP–18232) EXPERIMENTAL INVESTIGATION OF THE α-CLUSTER STRUCTURE OF ^6Li AND ^7Li WITH AN $(\alpha,2\alpha)$ REACTION AT 104 MeV. Velten, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Dec 1969. 67p. (In German). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Karlsruhe Univ., Ger.

The angular correlations of the reaction $(\alpha,2\alpha)$ were measured in symmetric coplanar geometry for investigation of the cluster structure of ^6Li and ^7Li in the angle region between 28 and 47° for ^6Li and between 30 and 44° for ^7Li. The incident energy of the α particles was 104 MeV with an energy resolution better than 1 MeV. The model of quasifree scattering, which yields a separation of the three-particle matrix element in one product from two-particle matrix element and pulse distribution of the α cluster in the nucleus, was used for the analysis of the measurements. The off-shell matrix element of the $\alpha-\alpha$ scattering was replaced approximately by the on-shell matrix element of the free $\alpha-\alpha$ scattering. The pulse distribution of a cluster in the nucleus can be determined both from the angular distribution and from the energy distribution. The pulse distribution for the α cluster in ^6Li calculated from the measured effective cross section yields the value L = 0 as the relative orbital angular momentum between α particles and deuterons. The pulse distribution for ^7Li is compatible with an orbital angular momentum L = 1 for the system α particle + triton. These pulse distributions were compared with models for the relative motion between core and α cluster. An oscillator wave function yields for small cluster pulses good agreement with the measured values, but deviations occur for large pulses. If a Hankel function is established for the asymptotic part of the wave function, the total pulse distribution is represented very well. (tr-auth)

40558 MECHANISM OF LITHIUM-INDUCED NUCLEAR REACTIONS. Carlson, R. R.; Johnson, D. J. (Univ. of Iowa, Iowa City). Phys. Rev. Lett.; 25: 172-5(20 Jul 1970).

Peaks in the zero-degree yield curve of the reaction $^{12}C(^7Li,\alpha)^{15}N$ are interpreted as due to resonances in the $^{12}C\alpha$ system. (auth)

40559 QUASIMOLECULAR STRUCTURE IN ELASTIC ^{16}O + ^{16}O SCATTERING. Scheid, Werner; Greiner, Walter; Lemmer, Richard (Univ., Frankfurt am Main). Phys. Rev. Lett.; 25: 176-80(20 Jul 1970).

It is suggested that the experimentally observed intermediate structure in the cross section of elastic ^{16}O + ^{16}O scattering is due to quasibound molecular states of the ion-ion system while the gross structure originates from virtually bound molecular states. (auth)

40560 THEORETICAL ANALYSIS OF THE REACTIONS (p,pd), (p,pα), AND $(\alpha,2\alpha)$ WITH THE ^6Li NUCLEUS. Mithra, Benoit; Lafoucriere, Joseph (Univ., Lyon). Compt. Rend., Ser. B; 270: 1434-7(1 Jun 1970). (In French).

The momentum distribution of the reactions (p,pd), (p,2α) and $(\alpha,2\alpha)$ with ^6Li are calculated using a polar model of the dispersion theory; the calculated results are compared with experimental results. Good agreement is obtained. However, for the reaction $Li(\alpha,2\alpha)D$ at 56 MeV the polar mechanism envisaged is inadequate, and it is necessary to consider higher-order diagrams; in particular, those of the final-state interaction must be considered. (France)

40561 DE-EXCITATION NEUTRONS FOLLOWING ^{14}N PHOTODISINTEGRATION. Sherman, N. K. (National Research Council of Canada, Ottawa); Gellie, R. W.; Lokan, K. H.; Johnson, R. G. Phys. Rev. Lett.; 25: 114-16(13 Jul 1970).

In a time-of-flight study of ^{14}N photoneutrons in which neutron energy spectra were obtained at different bremsstrahlung endpoint energies between 15.5 and 29.5 MeV, de-excitation neutrons from excited states of ^{13}C were observed. (auth)

40562 CALCULATION OF THE PHOTON-PRODUCTION SPECTRUM FROM PROTON–NUCLEUS COLLISIONS IN THE ENERGY RANGE 15 TO 150 MeV AND COMPARISON WITH EXPERIMENT. Shima, Y.; Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng.; 41: 47-55(Jul 1970).

Calculations of the differential photon-production cross sections from proton-nucleus collisions in the energy range 15 to 150 MeV were carried out and compared with experimental measurements on ^{12}C, ^{16}O, ^{27}Al, and ^{56}Fe. The calculations are based on the intranuclear-cascade-evaporation model of nuclear reactions and simple assumptions about the deexcitation of excited nuclei. The calculated total photon-production cross sections are within roughly a factor of two of the experimental values, but the calculated photon spectra are not in good agreement with the experimental spectra. (auth)

40563 REGGE POLE ANALYSIS OF THE ELASTIC SCATTERING OF α-PARTICLES FROM ^{16}O. Cowley, A. A.; Heymann, G. (Council for Scientific and Industrial Research, Pretoria). Nucl. Phys.; A146: 465-76(1970).

Angular distributions of α-particles scattered elastically from ^{16}O were measured at 7 energies between 25.4 and 32.2 MeV. The measurements were performed at laboratory angles of between 12.5° and 178.5°. The data are analyzed in terms of a combination of a Regge pole and strong absorption model. The spin of the backward-angle resonance observed at 29 MeV is extracted. (auth)

40564 ELASTIC AND INELASTIC SCATTERING OF 9.72 MeV NEUTRONS BY ^{10}B AND ^{11}B. Cookson, J. A.; Locke, J. G. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Phys.; A146: 417-26(1970).

Differential cross sections for elastic and inelastic scattering of 9.72 MeV neutrons from ^{10}B and ^{11}B were measured using the time-of-flight technique. The integrated elastic cross sections were 933 ± 68 mb and 895 ± 63 mb for ^{10}B and ^{11}B, respectively (the former including inelastic scattering to the 0.717 MeV state). For the excited states of ^{10}B and ^{11}B below 6.8 MeV excitation the integrated inelastic cross sections were 239 ± 27 mb and 385 ± 29 mb respectively. The inelastic angular distributions showed little sign of the forward peaking expected for a direct interaction. Comparison with Hauser–Feshbach theory gave, rather surprisingly, better agreement for ^{11}B than for ^{10}B. (auth)

40565 SPIN FLIP IN THE INELASTIC SCATTERING OF PROTONS FROM ^{12}C AT ENERGIES AROUND 13.1 MeV RESONANCE. Kobayashi, Shinsaku; Motonaga, Shoshichi; Chiba, Yoshiaki; Katori, Kenji; Stricker, Andreas; Fujisawa, Takashi; Wada, Takeshi (Inst. of Physical and Chemical Research, Yamato, Japan). J. Phys. Soc. Jsp.; 29: 1-8(Jul 1970).

Proton spin-flip probabilities in the scattering of $^{12}C(p,p')^{12}C^*$ (4.44 MeV) were measured in the energy range between 12 to 14 MeV. The differential cross sections in the elastic and inelastic scattering were also measured. The measurements were done in detail around the resonance in the elastic scattering cross section at 13.1 MeV. In this energy region, the spin-flip probability shows a remarkable energy dependence in contrast with a rather monotonous one of inelastic scattering cross section. The measurements were done by the (p, p'γ) coincidence technique due to Schmidt. (auth)

40566 SPIN AND PARITY ASSIGNMENTS FOR ^{17}O LEVELS FROM THE $^{13}C(\alpha,n)^{16}O_{g.s.}$ REACTION. Robb, A. D.; Schier, W. A.; Sheldon, E. (Univ. of Virginia, Charlottesville). Nucl. Phys.; A147: 423-48(1970).

The excitation function at 0° from $E_\alpha = 4.5$ MeV to 10.5 MeV (lab) and fourteen angular distributions from 0° to 170° over the energy range $E_\alpha = 4.995$ to 8.657 MeV (lab) have been measured for the $^{13}C(\alpha,n_0)^{16}O$ reaction proceeding by way of intermediate ^{17}O states with excitation energies from 9.8 to 14.4 MeV. After normalization to an absolute cross-section scale, the angular distributions were analyzed, using two-level compound-nucleus theory with provision for the coherent mixing of any two ^{17}O states having spin values up to 9/2, of either parity, and therefrom fourteen sets of spin-parity assignments were adduced for levels in ^{17}O at high excitation (10 to 13 MeV) corresponding to resonances in the excitation function, in conformity with previous tentative, approximate, assignments. (auth)

40567 INVESTIGATION OF THE REACTION $^{12}C(^7Li,t)^{16}O$. Puehlhofer, F.; Ritter, H. G.; Bock, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg. Univ., Marburg, Ger.). Nucl. Phys.; A147: 258-72(1970).

Angular distributions of the reaction $^{12}C(^7Li,t)^{16}O$ have been measured at E_{lab} = 15, 21.1 and 24 MeV with a magnetic spectrograph and a dE/dx–E telescope. From the shape of the angular distributions and the weak excitation of the 2^- state at E_x = 8.87 MeV in ^{16}O it is concluded that the reaction proceeds dominantly by a direct α-transfer. Contributions from compound nucleus formation were estimated from a Hauser–Feshbach calculation. The angular distributions were analyzed by means of the DWBA, which has been modified to take into account the relative p-state between the α-particle and the triton in ^7Li. Approximations valid for a surface reaction were used to simplify the theory. The calculations are able to reproduce the essential features of the angular distributions. Reduced α-widths were extracted for some states in ^{16}O. (auth)

40568 PROTON CAPTURE BY ^7Be. Aurdal, A. (NORDITA, Copenhagen). Nucl. Phys.; A146: 385-9(1970).

The cross sections for radiative capture of neutrons by ^7Li and protons by ^7Be are calculated using a single-particle model for the ground state of the ^8Li and ^8B nuclei respectively. The different model parameters were all determined from available experimental data on the $^7Li(n,n)^7Li$ and $^7Li(n,\gamma)^8Li$ processes. An extrapolation to energies relevant to the interior of stars was made. It is concluded that the importance of the reaction sequence $^7Be(p,\gamma)^8B(\beta^+,\nu)^8Be^*(\alpha)^4He$ as a termination of the proton-proton chain in stars is increased as compared to earlier estimates. (auth)

40569 ATOMIC BEAM MAGNETIC RESONANCE INVESTIGATIONS IN THE $2p^2\ ^3P$ GROUND MULTIPLET OF THE STABLE CARBON ISOTOPES ^{12}C AND ^{13}C. Wolber, G.; Figger, H.; Haberstroh, R. A.; Penselin, S. (Univ., Bonn). Z. Phys.; 236: 337-51 (1970).

The hyperfine structure separations $\Delta\nu$ and g_J-factors have been measured in the $2p^2\ ^3P$ states of $^{13}C(I = 1/2)$ and $^{12}C(I = 0)$, respectively, using the atomic beam magnetic resonance method. The results are $\Delta\nu(^3P_1, ^{13}C)$ = 4.200 (25) MHz, $\Delta\nu(^3P_2, ^{13}C)$ = 372.593 (25) MHz, $g_J(^3P_1, ^{12}C)$ = 1.501052 (13), and $g_J(^3P_2, ^{12}C)$ = 1.501039 (15). After applying corrections due to perturbations by neighboring fine structure levels, one deduces the constants of the magnetic dipole interaction $A(^3P_1, ^{13}C)$ = + 2.838 (17) MHz, $A(^3P_2, ^{13}C)$ = + 149.055 (10) MHz. No signs of the A-factors were determined by the experiment; they follow from the known positive sign of the nuclear magnetic moment μ_I of ^{13}C. Combining $A(^3P_2, ^{13}C)$ with the results of other measurements on ^{11}C, yields μ_I of (^{11}C) = −0.964 (1) nm. (auth)

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Refer also to abstracts 40242, 40550, 40556, 40562, 40598, 40607, 40608, 40613, 40672, and 40700–40703.

40570 (CALT-63-143) NUCLEAR SPECTROSCOPY AND X-RAY PROGRAM. Sixteenth Annual Report, October 1, 1969–September 30, 1970. Boehm, Felix (California Inst. of Tech., Pasadena. Norman Bridge Lab. of Physics). 20 Apr 1970. Contract AT(04-3)-63. 24p. Dep. CFSTI.

Research progress in the nuclear spectroscopy and x-ray program at California Institute of Technology from Oct. 1, 1969 to Sept. 30, 1970 is reported. The scope of the program is to study nuclear structure and the properties of the nuclear force, in particular its symmetries, using the tools of nuclear spectroscopy. (J.W.R.)

40571 (INP-699) ELASTIC AND INELASTIC SCATTERING OF 26.5-MeV ALPHA PARTICLES ON ^{28}Si, ^{31}P, AND ^{32}S NUCLEI. Chyla, K.; Niewodniczanski, H.; Szymakowski, J.; Tomza, U.; Wojciechowski, H. (Institute of Nuclear Physics, Krakow (Poland)). Mar 1970. 25p. Dep. CFSTI (U. S. Sales Only).

Differential cross sections for the scattering of alpha particles leading to the ground and the first two excited states of ^{28}Si and ^{31}P and the ground and first excited states of ^{32}S were measured over the angular range from 20° up to 177.5° (Lab. system) at 26.5 MeV. The differential cross sections obtained show well-pronounced maxima and minima. (auth)

40572 (NP-18290) THERMAL NEUTRON CAPTURE IN NATURAL CALCIUM. Boreving, S.; Falkstroem, E. (Forskningradens Laboratorium, Studsvik (Sweden). Chalmers Tekniska Hogskola, Goteborg (Sweden)). 1968. 26p. (LF-22). Dep. CFSTI (U. S. Sales Only).

Thermal neutron capture gamma rays from natural calcium were studied by means of Ge(Li) spectrometers. Energies and intensities of the gamma rays from the product nucleus ^{41}Ca are reported. The Q-value of the $^{40}Ca(n,\gamma)^{41}Ca$ reaction was determined as 8363.1 ± 0.5 keV. A decay scheme of the ^{41}Ca isotope is proposed, and a comparison is made between results from the $^{40}Ca(d,p)^{41}Ca$ and the $^{40}Ca(n,\gamma)^{41}Ca$ reactions. (auth) (Sweden)

40573 (NYO-2897-41) NUCLEAR CHEMISTRY RESEARCH OF HIGH-ENERGY NUCLEAR REACTIONS AT CARNEGIE-MELLON UNIVERSITY. Annual Progress Report, 1969–70. (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry). 1 Jun 1970. Contract AT(30-1)-2897. 90p. Dep. CFSTI.

Research progress on the study of nuclear reactions at Carnegie-Mellon University during the period June 1, 1969 to May 31, 1970 is reported. (J.W.R.)

40574 (ORNL-4515) NEUTRON ELASTIC- AND INELASTIC-SCATTERING CROSS SECTIONS FOR ^{56}Fe IN THE ENERGY RANGE 4.19 TO 8.56 MeV. Kinney, W. E.; Perey, F. G. (Oak Ridge National Lab., Tenn.). Jun 1970. Contract W-7405-eng-26. 143p. Dep. CFSTI.

Numerical values of neutron elastic- and inelastic cross sections to levels in ^{56}Fe per atom of natural iron for incident neutron energies from 4.19 to 8.56 MeV are presented. The results compare favorably with the results of others. Also, three sets of evaluated iron cross sections were compared with experimental data and was found that the total scattering cross sections are in fair agreement with the experimental data, but the differential elastic-scattering cross sections are not a good representation of the data beyond the first minimum. (auth)

40575 (RLO-1388-110) INELASTIC SCATTERING OF 42-MeV ALPHA PARTICLES BY ^{26}Mg. Naqib, I. M.; Blair, J. S. (Washington Univ., Seattle. Dept. of Physics). 24p. Dep. CFSTI.

Angular distributions for elastic and inelastic scattering of 42-MeV alpha particles by ^{26}Mg were measured in the range θ(lab) = 10° to 60°. Thirteen inelastic alpha groups were identified with the following-Q values: 1.79, 2.94, 3.60, 4.32, 4.91, 5.28, 5.485, 5.71, 6.92, 7.14, 7.45, 7.89, and 8.32 MeV. Through theoretical analysis, based on both the DWBA version of the extended optical model and the smoother Fraunhofer inelastic diffraction model, values of angular momentum transfer and transition strength were extracted. The combined evidence from the present and other experiments supports the assignments of 3^+(3.940 MeV), 4^+(4.331 MeV), and 4^+(5.485 MeV); also, the altered assignment of 4^+ for the 5.71-MeV level and $(0,2)^+$ for the 5.290-MeV level is suggested. The transitions to the low-lying levels in ^{26}Mg are found to be similar in character to the corresponding levels in ^{24}Mg, which are presumably members of the lowest $K = 0^+$ and $K = 2^+$ rotational bands. However, departures from the simple rotational model are more pronounced in ^{26}Mg where the nuclear surface appears to be less deformed and more "soft" with regard to vibrations than ^{24}Mg. Further, fragmented octupole strength is observed, as in ^{24}Mg, in the excitation energy range around 7 to 8 MeV. (auth)

40576 (RLO-1925-33) 8543-keV 6^+ STATE IN ^{28}Si AND THE GROUND-STATE ROTATIONAL BAND. Huang, F. C. P.; McDaniels, D. K. (Oregon Univ., Eugene. Dept. of Physics). [1970]. 15p. Dep. CFSTI.

Evidence for the existence of a ground-state rotational band in the nucleus ^{28}Si has been rounded out by a lifetime measurement of the 8543-keV 6^+ level. Using the 2203-keV resonance in the $^{27}Al(p,\gamma)^{28}Si$ reaction and the Doppler-shift attenuation technique, 18 ± 6 fs is found for the mean life of the 6^+ state. It follows that the strength of the $6^+ \rightarrow 4^+$ 3926-keV transition is 9.4 ± 3.0 W.u., in good agreement with theoretical predictions. This measurement removes objections that arose from an earlier result of 2.9 W.u. for the $6^+ \rightarrow 4^+$ transition strength. (auth)

40577 (SUNI-10) ANNUAL REPORT FOR THE YEAR ENDING DECEMBER 1969. McMurray, W. R. (comp.) (Southern Universities Nuclear Inst., Faure (South Africa)). 35p. Dep. CFSTI (U. S. Sales Only).

Research conducted at Southern Universities Nuclear Institute during 1969 is described. The operation and development of the 5.5 MeV Van de Graaff accelerator is summarized. Studies in nuclear structure and dynamics included neutron induced reactions, (p,n) and (d,n) reactions, (d,p) reactions, angular correlation studies, nuclear level lifetime measurements, compound nucleus reactions, and the Oxford time reversal project. Research in nuclear chemistry and radioisotope applications included activation analysis, isotope production, sand and sediment transport, and elemental analysis of leather cloth. (J.W.R.)

40578 EXPERIMENTAL OBSERVATION OF A "SPIN–SPIN EFFECT" IN THE NEUTRON TOTAL CROSS SECTION OF ^{59}Co. Healey, D. C. (Stanford Univ., Calif.); McCarthy, J. S.; Parks D.; Fisher, T. R. Phys. Rev. Lett.; 25: 117-19(13 Jul 1970).

Measurements of the "spin–spin effect" in the neutron total

cross section of ^{59}Co employing a polarized ^{59}Co target are reported. (auth)

40579 REDETERMINATION OF NUCLEAR QUADRUPOLE MOMENTS FROM HYPERFINE INTERACTIONS IN COMPOUNDS. Sawatzky, G. A.; Hupkes, Julieke (Univ. of Groningen, Netherlands). Phys. Rev. Lett.; 25: 100-1(13 Jul 1970).

A general expression is derived for the electric field gradient resulting from the overlap distortion of cation p orbitals by the surrounding ligands. This contribution can be larger than that arising from point charges and electric dipoles in the lattice. The inclusion of overlap distortion in the determination of the nuclear quadrupole moment Q of ^{27}Al in Al_2O_3 reduces Q from 0.377 to 0.155 b. The latter value is in good agreement with 0.149 b obtained from atomic-beam experiments. (auth)

40580 INCONSISTENCIES IN ANGULAR MOMENTUM ASSIGNMENTS TO NUCLEAR ENERGY LEVELS IN ^{41}Ca. Kocher, D. C.; Haeberli, W. (Univ. of Wisconsin, Madison). Phys. Rev. Lett.; 25: 36-8(6 Jul 1970).

The reaction ^{40}Ca(d,p)^{41}Ca has been studied with vector-polarized deuterons of an energy of 11 MeV. The measured vector analyzing power was used to make angular momentum assignments to states in ^{41}Ca at E_x = 3.62, 4.62, and 4.77 MeV. Two of the present j assignments are in disagreement with results obtained by other methods. Further experiments are needed to investigate the reliability of different methods of determining angular momenta of nuclear energy levels. (auth)

40581 HIGHER-ORDER EFFECTS FROM ISOSPIN-HINDERED ALLOWED BETA DECAY OF ^{56}Co. Singhal, Rajendra P. (Washington State Univ., Pullman). Nucl. Phys.; A147: 283-92(1970).

The available experimental data on spectrum shape, β-γ directional correlation, β-γ (circular polarization) correlation, and ft-value for isospin-hindered allowed positon decay of ^{56}Co has been utilized to deduce higher-order matrix elements. Finite nuclear size, screening, and finite de Broglie wavelength effects have been taken into account. The values 0.024, 0.018 and 0.0032 have been found for matrix element ratios $M(i\gamma_5 r)/M(\sigma)$, $-C_V M(\alpha \times r)/C_A M(\sigma)$, and $M((\sigma \cdot r)r)/M(\sigma)$, respectively. A new value for M_F: 0.00058 ± 0.00013 (quoted in natural units), taking into account higher-order corrections, is obtained. (auth)

40582 EXCITED LEVELS OF ^{20}Ne OBTAINED BY THE TRANSFER OF TWO PROTONS TO ^{18}O IN THE REACTION ^{18}O(^{3}He-n)^{20}Ne. Tamisier, Roland; Lebrun, Claude; Ardouin, Daniel; Deschamps, Yvon; Rosier, Louis-Hubert; Avignon, Paul (Nantes Univ., France). Compt. Rend., Ser. B; 270: 1309-12 (20 May 1970). (In French).

The angular distributions of neutrons corresponding to the excited states of ^{20}Ne at 0, 1.63, 5.80, (7.43 – 7.84), 10.27, 11.23, 13.06, and 13.65 MeV were analyzed by a mechanism involving the transfer of two protons in the Born distorted wave approximation. (D.W.B.A.) Satisfactory agreement was obtained. The spectrographic information deduced was compared with an intermediate coupling model and an SU_3 model. (France)

40583 ANOMALOUS BETA-ALPHA ANISOTROPY IN THE DECAY OF ^{20}Na. Oakey, Neil S. (Texas A and M Univ., College Station); Macfarlane, Ronald D. Phys. Rev. Lett.; 25: 170-2 (20 Jul 1970).

An anisotropy has been observed in the $\beta-\alpha$ directional correlation for an allowed β^+ decay in ^{20}Na. The effect is much larger than expected from interference from the second-order "weak magnetism" alone. The possibility of an enhanced E2 interference is discussed. (auth)

40584 GAMMA-RAY SPECTROSCOPY OF ^{42}K. Kawade, Kiyoshi (Nagoya Univ., Japan); Yamamoto, Hiroshi; Yoshikawa, Kanzo; Iizawa, Katsuyuki; Kitamura, Isao; Amemiya, Susumu; Katoh, Toshio; Yoshizawa, Yasukazu. J. Phys. Soc. Jap.; 29: 43-6(Jul 1970).

The decay of ^{42}K was investigated by a Ge(Li) detector and a 5″ ϕ × 4″ NaI scintillation counter. Two gamma-ray peaks were newly observed at 0.692 and 1.228 MeV in the gamma-gamma coincidence spectrum. The 0.587 MeV gamma-ray, previously reported by McCullen et al., could not be seen and the upper limit of the intensity of this gamma-ray relative to the 0.900 MeV gamma was 0.7%. (auth)

40585 44 MeV α-PARTICLE SCATTERING ON DOUBLY EVEN SPHERICAL NUCLEI NEAR CLOSED SHELLS AND NUCLEAR STRUCTURE OF COLLECTIVE STATES. Bruge, G. (CEN, Saclay, France); Faivre, J. C.; Faraggi, H.; Bussiere, A. Nucl. Phys.; A146: 597-658(1970).

A systematic study of collective states excited in 44 MeV α-particle inelastic scattering by nuclei near closed shells with 28 neutrons, 20, 28, 50 and 82 protons is presented. The nuclei studied are ^{40}Ca, ^{46,48,50}Ti, ^{52}Cr, ^{54,56,58}Fe, ^{58,60,62,64}Ni, ^{112,114,116,118,120,122,124}Sn and ^{208}Pb. The theoretical analysis was performed with the Austern–Blair model. The deformation lengths and transition probabilities obtained are compared with several experimental and theoretical data. A discussion of the two-phonon states is given. (auth)

40586 THE EXCITED STATES OF ^{62}Ni STUDIED BY THE (n,γ) REACTION. Fanger, U.; Heck, D.; Michaelis, W.; Ottmar, H.; Schmidt, H.; Gaeta, R. (Kernforschungzentrum, Karlsruhe, Ger.). Nucl. Phys.; A146: 549-76(1970).

The electromagnetic transition modes and level structure in ^{62}Ni were investigated via the radiative capture of thermal neutrons in ^{61}Ni. Enriched samples of 92.11% ^{61}Ni were used as external targets in filtered reactor neutron beams. High-energy precision was obtained by using Ge(Li) anti-Compton and Ge(Li) pair spectrometers. Coincidence relationships were found with a Ge(Li)–NaI(Tl) detector system, spin sequences and multipole mixing ratios were deduced by measurements with a NaI–NaI angular correlation apparatus. The experimental data allow the construction of a considerably extended transition diagram up to 5 MeV with new spin and parity assignments for a large number of levels. The neutron separation energy of ^{62}Ni was determined to be 10596.2 ± 1.5 keV. Based on intensities and δ-values, ratios of reduced transition rates can be given in some cases. The experimental level scheme and transition branching ratios are compared with results of several shell-model calculations. The agreement of excitation energies is fairly good up to 3.2 MeV. (auth)

40587 INELASTIC DEUTERON SCATTERING FROM ^{56}Fe AND ^{58}Fe. Jolly, R. K.; Armitage, B. H.; Sengupta, A. K. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys.; A146: 514-22(1970).

Angular distributions of inelastically scattered deuterons from ^{56}Fe and ^{58}Fe were measured at incident deuteron energies of 11.5 and 11.8 MeV respectively using a broad-range spectrograph. The experimental angular distributions were compared with the results of DWBA calculations using complex coupling and including the contribution from Coulomb excitation. Values of β_l were extracted and in general the spin and parity assignments agree well with previous work. (auth)

40588 THE LOWEST NEGATIVE PARITY STATE IN ^{21}Na. Christiansson, J. E.; Dubois, J.; Jarneborn, L. (Chalmers Univ. of Tech., Goteborg. Univ. of Goteborg). Nucl. Phys.; A146: 390-6(1970).

The ^{20}Ne(d,n)^{21}Na reaction was studied at E_d = 4.5 MeV. The neutron angular distributions indicate l_p = 0 and 1 for the 2.41 and 2.79 MeV levels, respectively. The 2.79 MeV level is interpreted as the head of a rotational band based on Nilsson orbit $\frac{1}{2}^-$[101]. (auth)

40589 ^{62}Ni LEVELS AND THE DECAY OF ^{62}Cu. Van Patter, D. M. (Franklin Inst., Swarthmore, Pa.); Neuffer, D.; Scott, H. L.; Moazed, C.; Hinrichsen, P. F. Nucl. Phys.; A146: 427-37(1970).

The intensities and energies of γ-rays following the decay of ^{62}Cu were measured using a Ge(Li)–NaI(Tl) spectrometer operated in the Compton suppression mode. Seven γ-rays were observed with the following energies in keV and relative intensities in percent per decay: 875.2 ± 0.3 (0.15 ± 0.01), 1129.1 ± 0.4 (0.034 ± 0.004), 1172.7 ± 0.3 (0.35 ± 0.02), 2085.3 ± 0.6 (0.005 ± 0.001), 2301.8 ± 0.5 (0.044 ± 0.003), 2345 ± 2 (0.003 ± 0.001) and 3371.1 ± 1.5 (0.011 ± 0.001). Possible transitions of 1718 (0.004 ± 0.002) and 2097 keV (0.002 ± 0.001) were also noted. The strongest ^{62}Cu → ^{62}Ni$^+$ decay is the newly discovered mode to the 3371 keV level (log ft = 5.5). Upper limits for unobserved decays to known low spin states in ^{62}Ni were established. (auth)

40590 THE CHARACTER OF EXCITED STATES IN ^{41}Sc STUDIED BY ELASTIC AND INELASTIC PROTON SCATTERING FROM ^{40}Ca. Marinov, A.; Drory, Ch.; Navon, E.; Burde, J.; Engler, G. (Hebrew Univ., Jerusalem). Nucl. Phys.; A145: 534-48(1970).

Excitation functions of elastic and inelastic proton scattering leading to the ground state and to the 0^+(3.35 MeV), 3^-(3.74 MeV) and 2^+(3.91 MeV) excited states of ^{40}Ca were measured at 90°, 125° and 160° at bombarding energies from 4.8 to 6.2 MeV. Sixty resonances were identified. Angular distributions of the inelastically scattered protons were measured at bombarding energies corresponding to most of the resonances observed in the excitation curves. The spins of the corresponding levels in ^{41}Sc and their partial widths for decay to the ground state and to the three excited states in ^{40}Ca were determined in most of the cases. In a few cases de-excitation to the 5^- state at 4.49 MeV excitation in ^{40}Ca was also observed. Levels in ^{41}Sc having configurations with large two-particle one-hole component were identified and

compared with similar levels in ^{41}Ca and with theoretical predictions. (auth)

40591 LIFETIME OF THE 632 keV $5/2^+$ LEVEL IN ^{77}As. Tucker, A. B.; Meeker, R. D. (Ames Lab., Iowa). Nucl. Phys.; A145: 362-8(1970).

The half-life of the $5/2^+$ level at 632 keV in ^{77}As has been measured with the delayed coincidence technique, using γ-rays emitted following the decay of ^{77}Ge. Centroid shift and slope analyses of the ^{77}Ge decay data give a half-life of 75 ± 15 psec. Reduced transition probabilities are calculated and compared with the corresponding quantities for ^{75}As. (auth)

40592 EVIDENCE FOR $\Delta T = 1$ MAGNETIC QUADRUPOLE TRANSITIONS IN ^{24}Mg EXCITED BY 180° ELECTRON SCATTERING. Fagg, L. W. (Naval Research Lab., Washington, D. C.); Bendel, W. L.; Numrich, S. K.; Chertok, B. T. Phys. Rev., C; 1: 1137-8(Mar 1970).

The data of an earlier paper presenting the results of 180° electron scattering from ^{24}Mg are reexamined using more refined data-treatment techniques. Present results favor an assignment of 2^- for T = 1 states at 12.91 and 13.37 MeV with estimates for radiation widths Γ_γ of 0.11 and 0.13 eV, respectively. Revised transition widths for the 1^+, T = 1 states at 9.94 and 10.70 MeV are found to be 7.6 and 17.6 eV, respectively, in better agreement with results of other workers. (auth)

40593 POSSIBLE ROLE OF ISOBARIC ANALOG STATES IN ^{56}Fe(p,p'). Arns, R. G.; Duray, J. R.; Hausman, H. J.; Nichols, D. B.; Seyler, R. G. (Ohio State Univ., Columbus). Phys. Rev., C; 1: 2152-5(Jun 1970).

Excitation functions for proton-elastic and inelastic scattering from ^{56}Fe, studied from 2.0- to 6.0-MeV bombarding energy and for various scattering angles, reveal structure which is ascribed to isobaric analog resonances of the nucleus ^{57}Fe. The conjecture that these resonances may have a significant influence on the spin-flip probability observed in inelastic scattering is tested by varying the transmission coefficients in a Hauser–Feshbach calculation. It is found that this effect can give rise to an enhancement of the calculated spin-flip probability consistent with previous measurements. (auth)

40594 YIELDS OF STABLE AND RADIOACTIVE RARE-GAS ISOTOPES FORMED BY 3- AND 29-GeV PROTON BOMBARDMENT OF Cu, Ag, Au, AND U. Hudis, J.; Kirsten, T.; Stoenner, R. W.; Schaeffer, O. A. (Brookhaven National Lab., Upton, N. Y. State Univ. of New York, Stony Brook). Phys. Rev., C; 1: 2019-30(Jun 1970).

The yields of all rare-gas products, including stable species, with half-lives >10 h, produced in 3- and 29-GeV proton bombardment of Cu, Ag, Au, and U are measured. Mass-spectrometric measurements of ^{20}Ne, ^{21}Ne, ^{38}Ar, ^{83}Kr, and ^{131}Xe represent total chain yields for these mass numbers. Spallation processes can account for Ne yields from Cu; Ar and Kr from Ag; and Xe from Au. Fission and spallation mechanisms satisfactorily describe the Kr from Au and the Kr and Xe from U. Ne and Ar yields from Au and U do not seem to be formed by spallation and fission processes, but appear to result from the same processes which lead to high yields of even lighter fragments previously observed in high-energy reactions. (auth)

40595 MEAN LIFETIMES OF LOW-LYING LEVELS OF ^{34}S. Ragan III, C. E. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.); Poore, R. V.; Roberson, N. R.; Mitchell, G. E.; Tilley, D. R. Phys. Rev., C; 1: 2012-18 (Jun 1970).

The mean lifetimes of the levels of ^{34}S below 5.0-MeV excitation energy are measured by the Doppler-shift attenuation method. The ^{31}P(α,p)^{34}S reaction is used to populate these states. GaP targets evaporated onto 1-μ Ni foils are bombarded with α particles ranging in energy from 5.0 to 7.3 MeV. γ rays are detected with a 30-cc Ge(Li) detector at 0, 90, and 143° to the beam axis. The following mean lifetimes are found: τ(2.13-MeV level) = 400 ± 32 fsec, τ(3.30) = 175 ± 25 fsec, τ(3.92) > 1.39 psec, τ(4.07) < 24 fsec, τ(4.11) = 110 ± 10 fsec, τ(4.62) = 135 ± 17 fsec, τ(4.69) = 131 ± 13 fsec, τ(4.88) = (57 ± 22 fsec), τ(4.89) = (52 ± 14 fsec). (auth)

40596 LEVELS OF ^{55}Mn FROM THE ^{53}Cr(p,nγ)^{55}Mn REACTIONS. McEllistrem, M. T.; Jones, K. W.; Sheppard, D. M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 1: 1409-16(Apr 1970).

In a study of the ^{53}Cr(p,nγ)^{53}Mn reactions, levels of ^{53}Mn are found at 377.5, 1288.4, 1440.1, and 1619.1 keV, with uncertainties of ±0.3 keV. The observation of γ-ray anisotropies and (p,n) cross-section ratios permits unique spin assignments to three of the levels. Analysis of the (p,n) cross-section ratios using the Hauser–Feshbach formalism is consistent with the results of earlier experiments for the two lower levels. The spins of the above levels are, in the order given above, $5/2$, $3/2$, $11/2$, and $3/2$. Mixing ratios for the 377.5- and 1619.1-keV transitions are measured to be −0.6 ± 0.3 and −3.2 ± 0.8, respectively. (auth)

40597 ELASTIC AND INELASTIC PROTON SCATTERING ON ^{29}Si. Poirier, C. P.; Walinga, J.; Manthuruthil, J. C.; Harris, Gale I. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio). Contract F33615-67-C-1758. Phys. Rev., C; 1: 1982-93(Jun 1970).

High-resolution measurements of the differential cross section for elastic proton scattering on ^{29}Si are performed in the energy range E_p = 1.1–2.5 MeV, which corresponds to the range $E_x(^{30}P)$ = 6.7–8.1 MeV. Twenty-four resonances are observed, including ten previously unreported resonances. For all but two resonances, the proton orbital momenta are determined, and, in many cases, unique spin assignments are made. Partial proton widths or strengths are given for all resonances. Five 1^- resonances are observed with the unusually large total p-wave reduced width θ_p^2 = 1.14 in the elastic channel. Similarly, four 2^- resonances appear with a total p-wave reduced width θ_p^2 = 0.68. For the 1^- resonances, both $p_{\frac{1}{2}}$ and $p_{\frac{3}{2}}$ elastic scattering contribute strongly. Two definite, and one probable, 4^- resonances are observed with a total f-wave reduced width θ_p^2 = 0.15. The yield of inelastically scattered protons from the first excited state of ^{29}Si is measured in the energy range E_p = 1.9–2.5 MeV. Eleven resonances are observed, including three previously unreported resonances. The resonance strengths are measured relative to the known strength of the 1302-keV resonance in the ^{29}Si(p,γ)^{30}P reaction. For the resonances with known spin, the partial inelastic proton widths are obtained. (auth)

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Refer also to abstracts 39321, 40257, 40550, 40570, 40573, 40585, 40680, and 40700–40703.

40598 (AAEC/TM–522) ANALYSIS OF (n-2n) CROSS SECTIONS. Bertram, W. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nov 1969. 7p. Dep. CFSTI (U. S. Sales Only).

The statistical model is used to derive an expression for the (n-2n) excitation function, taking into account (n-3n) competition. The (n-2n) cross sections thus obtained are found to agree with experiment over a wide range of energies extending well beyond the (n-3n) threshold. (auth) (Australia).

40599 (AD–702889) Ge(Li) DETECTOR STUDY OF GAMMA RAYS FROM GROUND-STATE DECAY OF ^{190}Ir. Temperley, Judith K.; Barnes, Donald E. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Dec 1969. 28p. (BRL–1460). CFSTI.

The gamma-ray spectrum following the decay of ^{190g}Ir to ^{190}Os was investigated with a Ge(Li) detector. The energies and relative intensities of 42 gamma rays, including ten transitions previously unreported, were determined. Using the conversion electron intensities measured by previous investigators, the K-conversion coefficients of the transitions were calculated and used to assign spins and parities to the levels of ^{190}Os. (auth) (USGRDR)

40600 (ANL–7625) SOME MEASUREMENTS OF PROMPT-NEUTRON FISSION YIELD ($\bar{\nu}_p$) IN THERMAL-NEUTRON FISSION OF ^{232}U, ^{238}Pu, ^{241}Pu, ^{241}Am, ^{242m}Am, ^{243}Cm, ^{245}Cm, AND IN SPONTANEOUS FISSION OF ^{244}Cm. Jaffey, A. H.; Lerner, J. L. (Argonne National Lab., Ill.). Nov 1969. Contract W-31-109-eng-38. 54p. Dep. CFSTI.

The prompt-neutron fission yield ($\bar{\nu}_p$) was measured in thermal-neutron fission of ^{232}U, ^{238}Pu, ^{241}Pu, ^{241}Am, ^{242m}Am, ^{243}Cm, ^{245}Cm, and in the spontaneous fission of ^{244}Cm. These were measured by comparison with $\bar{\nu}_p$-values of the standards ^{233}U, ^{235}U, ^{239}Pu, and ^{252}Cf. A coincidence method was used, with fission fragments detected in an ionization chamber at close to 100% efficiency, and with fission neutrons detected using four symmetrically placed ZnS(Ag)-methyl methacrylate discs (Hornyak buttons). A small variation of neutron-detection efficiency with fission-neutron spectrum differences was calibrated with the four standard nuclides. The measured values of $\bar{\nu}_p$ are: ^{232}U, 3.130 ± 0.060; ^{238}Pu, 2.895 ± 0.027; ^{241}Pu, 2.874 ± 0.015; ^{241}Am, 3.219 ± 0.038; ^{242m}Am, 3.264 ± 0.024; ^{243}Cm, 3.430 ± 0.047; ^{245}Cm, 3.832 ± 0.034; ^{244}Cm, 2.692 ± 0.024. (auth)

40601 (CNIE–IC–2) X-RAY SPECTROSCOPY RELATED TO THE DETERMINATION OF ELECTRON-CAPTURE RATIOS. Bosch, H. E.; Fariolli, M. A.; Martin, N.; Simon, M. C. (Co-

mision Nacional de Investigaciones Espaciales, Buenos Aires (Argentina)). 1969. 32p. Dep. CFSTI.

The methods employed for measuring LM/K capture ratios were analyzed, and the corresponding data were compiled in different tables. An alternative method is introduced using very thin NaI(Tl) crystals to detect x rays, in conjunction with Ge(Li) counters for gamma rays. A triple coincidence arrangement was used. Calibration in energy and absorption corrections were made. The particular transitions of ^{133}Ba to ^{133}Cs (437-keV level), ^{57}Co to ^{57}Fe (136-keV level), and ^{57}Co to ^{57}Fe (706-keV level) were studied. The values of the LM/K ratios obtained were 1.15 ± 0.08, 0.15 ± 0.02, and 0.088 ± 0.040, respectively. When possible, Q-values were derived from the data obtained and compared with mass-table predictions. (auth)

40602 (COO-1746-32) MEASUREMENTS OF THE STATIC QUADRUPOLE MOMENT OF THE FIRST EXCITED 2^+ STATES OF THE NUCLEI ^{106}Pd AND ^{110}Pd BY HEAVY ION COULOMB EXCITATION. Beyer, R.; Scharenberg, R. P.; Thomson, J. (Purdue Univ., Lafayette, Ind. Dept. of Physics). [1969]. Contract AT(11-1)-1746. 40p. Dep. CFSTI.

The static quadrupole moments of the 511.7 keV 2^+ state in ^{106}Pd and the 373.8 keV 2^+ state in ^{110}Pd were determined by employing Coulomb excitation techniques. Foils (~175 $\mu g/cm^2$) of separated Pd isotopes were bombarded with 25- and 30-MeV ^{16}O ions and 55- and 56-MeV ^{32}S ions from the Purdue University and Argonne National Laboratory Tandem accelerators. The angular distributions of the inelastically scattered ions were measured in coincidence with the de-excitation gamma rays to determine the relative excitation probabilities. The experimental data were fitted using the Winther-de Boer Multiple Coulomb Excitation Program so that the sign and magnitude of the static quadrupole moment could be extracted. The effect of higher excited states on the excitation probability of the 2^+ state was calculated using the matrix elements determined by Robinson et al. and the Winther-de Boer program. Self consistency of the oxygen and sulfur data suggests that the excitation via the second 2^+ state interferes constructively so as to increase the excitation probability. With this choice for the interference via the second 2^+ state, the values of the static quadrupole moments are $Q_{22} = -.458 \pm .059$ barns for ^{106}Pd and $Q_{22} = -.483 \pm .049$ barns for ^{110}Pd. If the excitation via the second 2^+ state interferes destructively, the values of the static quadrupole moments are $Q_{22} = -.282 \pm .059$ barns for ^{106}Pd and $Q_{22} = -.266 \pm .049$ barns for ^{110}Pd. (auth)

40603 (COO-1779-15) NEUTRON-DEFICIENT MEMBERS OF THE A = 139 DECAY CHAIN. I. 5.5-HOUR ^{139m}Nd AND 30-MINUTE ^{139g}Nd. Beery, D. B.; Kelly, W. H.; McHarris, Wm. C. (Michigan State Univ., East Lansing). [1969]. 86p. Dep. CFSTI.

The γ rays emitted following the decays of 5.5-h ^{139m}Nd and 30-min ^{139g}Nd with Ge(Li) and NaI(Tl) detectors in singles, coincidence, and anti-coincidence configurations are studied. The study has indicated 51 γ rays accompanying ^{139m}Nd decay and 21 that follow ^{139g}Nd decay. Of these, 56 were placed in decay schemes containing a total of 22 excited states. The decay scheme of $^{3}/_{2}^{+}$ ^{139g}Nd has much in parallel with those of similar nuclei in this region, and states are populated in ^{139}Pr at 0 ($^{5}/_{2}^{+}$), 113.8 ($^{1}/_{2}^{+}$), 405.0 ($^{3}/_{2}^{+}$,$^{1}/_{2}^{+}$), 589.2 ($^{5}/_{2}^{+}$), 916.8 ($^{1}/_{2}^{+}$,$^{3}/_{2}^{+}$), 1074.4 ($^{1}/_{2}^{+}$,$^{3}/_{2}^{+}$), 1311.8 ($^{1}/_{2}^{+}$,$^{3}/_{2}^{+}$,$^{5}/_{2}^{+}$), 1328.2 ($^{5}/_{2}^{+}$), 1405.5 ($^{1}/_{2}^{+}$,$^{3}/_{2}^{+}$,$^{5}/_{2}^{+}$), 1449.5 ($^{1}/_{2}^{+}$,$^{3}/_{2}^{+}$,$^{5}/_{2}^{+}$), and 1501.2 keV ($^{1}/_{2}^{+}$,$^{3}/_{2}^{+}$). On the other hand, $^{11}/_{2}^{-}$ ^{139m}Nd decays only 12.7% via a 231.2-keV M4 isomeric transition and independently decays by electron capture to a set of almost completely different states in ^{139}Pr. These are at 0 ($^{5}/_{2}^{+}$), 113.8 ($^{1}/_{2}^{+}$), 821.9 ($^{11}/_{2}^{-}$), 828.1 ($^{1}/_{2}^{+}$,$^{3}/_{2}^{+}$), 851.9 ($^{3}/_{2}^{+}$,$^{7}/_{2}^{+}$), 1024.0 ($^{1}/_{2}^{+}$,$^{3}/_{2}^{+}$,$^{11}/_{2}^{+}$), 1396.6 ($^{3}/_{2}$,$^{11}/_{2}$,$^{13}/_{2}$), 1523.2, 1624.5 ($^{9}/_{2}^{-}$,$^{11}/_{2}^{-}$), 1834.1 ($^{9}/_{2}^{-}$,$^{11}/_{2}^{-}$), 1927.1 ($^{9}/_{2}^{-}$,$^{11}/_{2}^{-}$), 2048.8 ($^{9}/_{2}^{-}$,$^{11}/_{2}^{-}$), 2174.3 ($^{9}/_{2}^{-}$,$^{11}/_{2}^{-}$), and 2196.7 keV ($^{9}/_{2}^{-}$, $^{11}/_{2}^{-}$). Some 80.7% of its decay goes to the last six, and they are interpreted as being three-quasiparticle states. It appears that ^{139m}Nd is one of a few nuclides whose intrinsic structure forces the preferred mode of decay to go into a three-quasiparticle multiplet, i.e., $(\pi d_{5})^{2}(\nu d_{5})^{-1}(\nu h_{11})^{-1} \rightarrow (\pi d_{5})(\nu d_{5})^{-1}(\nu h_{11})^{-1}$. The three-quasiparticle states are depopulated by numerous enhanced γ transitions between states in their multiplet and fewer apparently highly hindered transitions to lower states. Thus, the potential exists for extracting information about states near 2 MeV in this nucleus that normally is available only for states near the ground state. (auth)

40604 (GEAP-13591) ^{239}Pu UNRESOLVED RESONANCE DATA FOR ENDF/B, VERSION II. Hitchcock, J. T.; Hutchins, B. A. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Apr 1970. Contract AT(04-3)-189. 30p. Dep. CFSTI.

An evaluation of the ^{239}Pu neutron cross section data in the unresolved resonance region (300 eV to 25 keV) has been completed and a set of recommended Breit-Wigner statistical parameters sent to the National Neutron Cross Section Center for the ENDF/B nuclear data file, Version II. This new evaluation was undertaken to include recent, high-resolution fission cross section and alpha measurements below 25 keV. The s-wave parameters chosen, together with a small p-wave contribution, produce cross sections which agree well with both the measured $\sigma(n,f)$ and alpha values. (auth)

40605 (IN-1261) CATALOGUE OF SEMICONDUCTOR ALPHA-PARTICLE SPECTRA. Chanda, R. N.; Deal, R. A. (Idaho Nuclear Corp., Idaho Falls). Mar 1970. Contract AT-(10-1)-1230. 159p. Dep. CFSTI.

The first compilation of alpha-particle spectra obtained with silicon surface-barrier detectors is presented. Spectra are presented of 35 nuclides ranging from Z = 83 to 89. Included are nuclides of both the natural decay chains and a number of the most frequently encountered artificially produced nuclides. A thin source preparation method, described was used. In order that these spectra be useful for analytical purposes, all spectra were recorded under a standard set of conditions that can be readily reproduced in other laboratories. Conditions such as detector size, resolution, geometry, sample size, and gain scale were standardized. The spectra are presented in graphical as well as digital form. In addition, the electronics, use of detectors, and sample preparation techniques are described in detail. To further aid the user of the catalogue, appendices are included listing nuclides according to Z, A, and alpha-particle energy, a table of specific activities, the natural radioactive series and a range-energy curve. (auth)

40606 (IN-1317) NUCLEAR TECHNOLOGY BRANCH ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1969. Brugger, R. M.; Heath, R. L. (eds.) (Idaho Nuclear Corp., Idaho Falls). Jan 1970. Contract AT(10-1)-1230. 404p. Dep. CFSTI.

Separate abstracts were prepared for six sections of the report. Additional sections are included on experimental techniques, solid state detector development, experimental apparatus and electronics, and cooperative programs with educational institutions. (H.L.W.)

For abstracts of individual sections see: 39207, 39537, 40181, 40539, 40607, and 40608.

40607 (IN-1317, pp 1-63) NEUTRON INTERACTIONS WITH NUCLEI. (Idaho Nuclear Corp., Idaho Falls).

ALUMINUM-27 — neutron reactions with, activation cross sections for fast, (E)
AMERICIUM-241 — neutron capture by, resonance integral for
AMERICIUM-242 — neutron capture by, resonance integral for
AMERICIUM-243 — neutron resonance parameter at 0.4 to 7 eV, (E)
CURIUM-242 — neutron capture by, resonance integral for
CURIUM-243 — neutron resonance parameters and total cross section at 0.01 to 10 eV, (E)
CURIUM-244 — neutron resonance integral for, (E)
CURIUM-245 — neutron resonance integral for, (E)
— neutron resonance parameters and total cross section at 0.01 to 10 eV, (E)
CURIUM-246 — neutron resonance parameters and total cross section at 0.01 to 10 eV, (E)
— neutron resonance integral for, (E)
GOLD — neutron reactions with, activation cross sections for fast, (E)
IRON — neutron spectra in, (E)
NICKEL — neutron reactions with, activation cross sections for fast, (E)
NIOBIUM-94 — neutron resonance parameters at less than 50 eV, (E)
NUCLEI — neutron reactions at 2 keV with A = 23 to 238, activation cross sections for, (E)
PLUTONIUM-239 — neutron fission at 2 keV, α and η values for, (E)
— neutron reactions at 2 keV, partial cross sections and α value for, (E)
PLUTONIUM-241 — neutron total cross section at 0.0253 eV, (E)
PLUTONIUM-244 — neutron capture up to 0.5 eV, cross section and resonance integral for, (E)
PROMETHIUM-147 — neutron resonance parameters at 65 to 250 eV, (E)
SAMARIUM-147 — neutron resonance parameters at 65 to 250 eV, (E)
THORIUM-232 — neutron resonance parameters at 65 to 250 eV, (E)
TITANIUM — neutron reactions with, activation cross sections for fast, (E)
URANIUM-235 — neutron fission at 2 keV, α and η values for, (E)
URANIUM-236 — neutron resonance parameters up to 400 eV, (E)
ZINC — neutron reactions with, activation cross sections for fast, (E) (J.W.R.)

40608 (IN–1317, pp 69–151) NUCLEAR PROPERTIES. (Idaho Nuclear Corp., Idaho Falls).

ALUMINUM-27—proton spallation at 600 MeV, cross sections for, (E)
ARSENIC-69—beta decay of, γ energies from, (E)
BARIUM-141—beta decay of, γ spectra from, (E)
BARIUM-142—beta decay of, γ spectra from, (E)
COBALT-56—beta and electron-capture decay of, γ spectra from, (E)
COPPER—proton spallation at 600 MeV, cross sections for, (E)
DYSPROSIUM-164—energy levels from dysprosium-153 neutron capture, (E)
ERBIUM-166—energy levels of, analysis of mixing of ground-state and γ-vibrational bands, (ET)
GADOLINIUM-156—energy levels from gadolinium-155 neutron capture, reduced transition probabilities for, (E)
GADOLINIUM-158—energy levels from gadolinium-157 neutron capture, reduced transition probabilities for, (E)
IRON-56—energy levels from cobalt-56 decay, (E)
LANTHANUM-141—energy levels from barium-141 decay, (E)
LANTHANUM-142—energy levels from barium-142 decay, (E)
MANGANESE-55—neutron capture at thermal and 2 keV energies, γ spectra from, (E)
NICKEL—proton spallation at 600 MeV, cross sections for, (E)
NIOBIUM-94—beta decay of, γ energies from, (E)
PALLADIUM-101—beta and electron-capture decay of, γ energies from, (E)
PALLADIUM-103—electron-capture decay of, γ spectra from, (E)
RHODIUM-99—beta and electron-capture decay of ground-state and isomeric, γ spectra from, (E)
RHODIUM-103—energy levels from ruthenium-103 and palladium-103 decays, (E)
RUTHENIUM-99—energy levels from rhodium-99 decay, (E)
RUTHENIUM-103—electron-capture decay of, γ spectra from, (E)
TANTALUM-181—neutron capture at thermal and 2 keV energies, γ spectra from, (E)
TANTALUM-182—energy levels from tantalum-181 neutron capture, (E)
TECHNETIUM-94—beta and electron-capture decay of ground-state and isomeric, γ energies from, (E)
YTTERBIUM-171—neutron capture at 2 keV, γ spectra from, (E)
—energy levels from ytterbium-170 neutron capture, (E)
YTTERBIUM-172—energy levels from ytterbium-171 neutron capture, (E)
YTTERBIUM-174—energy levels from ytterbium-173 neutron capture, (E)
ZIRCONIUM-95—beta decay of, γ energies from, (E) (J.W.R.)

40609 (INR–1169) THE LEVEL STRUCTURE OF NEAR ^{208}Pb NUCLEI (NEUTRON-DEFICIENT Pb AND Bi ISOTOPES). Kusch, W. (Institue of Nuclear Research, Warsaw (Poland)). 1970. 120p. (In Polish). Dep. CFSTI (U. S. Sales Only).

The level scheme structure of the near ^{208}Pb nuclei, especially of neutron-deficient Pb and Bi isotopes is discussed. The experimental results, as well as theoretical ones, concerning the calculations of the excited states in the frame of the shell model are presented. The regularity of the level structure revealed by the existence of isomeric states among these nuclei and the effects of the particle-vibration coupling are pointed out. Special attention is paid to the results concerning the ^{204}Po decay to the excited states of ^{204}Bi recently obtained by the author. A tentative level scheme for ^{204}Bi can be proposed on the basis of the results of measurements of the γ spectra, coincidence γ–γ spectra, and electron conversion spectra. (auth)

40610 (IS-T-352) GAMMA RAY DECAY SCHEMES FOR ^{142}Xe, ^{142}Cs, ^{142}Ba, ^{142}La. Larsen, Jon Thorsten (Ames Lab., Iowa). Feb 1970. Contract W-7405-eng-82. 140p. Dep. CFSTI.

Thesis.

Measurements are reported for gamma energies and intensities present in the decays of the four nuclei ^{142}Xe, ^{142}Cs, ^{142}Ba, and ^{142}La. These nuclei are all members of the isobaric decay chain beginning with ^{142}Xe, which was made available by use of an on-line isotope separator system developed for the study of gaseous fission products. Partial energy level schemes were constructed for ^{142}Cs, ^{142}Ba, ^{142}La, and ^{142}Ce with the aid of Ge(Li)–Ge(Li) coincidence data. Some spin–parity assignments were made for levels in ^{142}Ba and ^{142}Ce; comparative half-lives were calculated for the decays of ^{142}Ba and ^{142}La. An attempt is made to interpret some of the energy levels in the even–even ^{142}Ba and ^{142}Ce nuclei; these nuclei appear to exhibit vibrational-like excitations. (auth)

40611 (IS-T-375) PHOTOFISSION OF ^{235}U AND ^{238}U USING A COMPTON SCATTERING MONOCHROMATOR. Hall, James Edison (Ames Lab., Iowa). May 1970. Contract W-7405-eng-82. 92p. Dep. CFSTI.

Thesis.

The photofission yields from ^{235}U and ^{238}U were measured in the energy range 4.7 to 8.0 MeV using a surface-barrier semiconductor detector. ^{252}Cf was used to calibrate the response of the fission fragment detection system. Structure was evident in the photofission yield from ^{238}U, but not from ^{235}U. Conclusions about the fission cross sections of these nuclides can be drawn from the yield curves. These are discussed on the basis of Bohr's theory of "fission channels" and Strutinsky's double-humped potential. In order to conduct these photofission experiments, it was necessary to design, construct, and calibrate a variable energy gamma source. The source was a beam of neutron-capture gamma rays of maximum energy 8996 keV whose energy was varied by Compton scattering from a curved aluminum plate. The intensity of the scattered 8996 keV line incident on the fission target (2.00 × 0.75 in.) was 10^5 per sec at a scattering angle of 13.45 degrees (6067 keV). (auth)

40612 (ITEF–748) NEW DATA CONCERNING THE LOWER EXCITED LEVELS OF ^{225}Ra. Tret'yakov, E. F.; Tret'yakova, N. I.; Konyaev, V. F.; Khrudev, Yu. V.; Beda, A. G.; Kartashev, G. F.; Vishnevskii, I. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1969. 20p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Results of studying conversion electrons, γ, and α emission accompanying the ^{229}Th decay are given. The scheme of ^{225}Ra levels is discussed. (auth)

40613 (JINR–P3-4929) ANALYSIS OF THE TOTAL RADIATION WIDTHS OF THE NUCLEAR NEUTRON RESONANCES. Malecki, H.; Pikelner, L. B.; Salamatin, I. M.; Sharapov, E. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1970. 22p. (In Russian). (CONF-700605–1). Dep. CFSTI (U. S. Sales Only).

From 2nd International Conference on Nuclear Data on Reactors, Helsinki, Finland.

For a large number of nuclei in the mass range 60 to 247 a comparison is made of the experimental total radiation widths with theory. An empirical dependence is suggested for the radiation widths. (auth)

40614 (JINR–P7-5108) INVESTIGATION OF THE REGULARITIES OF THE PRODUCTION OF SPONTANEOUSLY FISSIONABLE ISOTOPE OF ELEMENT 105. Flerov, G. N.; Oganesyan, Yu. Ts.; Lobanov, Yu. V.; Lazarev, Yu. A.; Kuznetsov, V. I.; Tret'akova, S. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1970. 13p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Excitation functions of spontaneously fissionable isotopes of elements 102 and 105 were studied in bombarding ^{235}U and ^{243}Am by accelerated Ne-22 ions. It is shown that previously observed spontaneously fissionable element 105 isotope with $\tau_{\frac{1}{2}} = 2.2 \pm 0.5$ s has an excitation function with a maximum at the ion energy of 117 MeV and width on the half-height of 8 MeV. It follows from the totality of experimental data that this emitter is produced in the complete fusion reaction with the posterior evaporation of neutrons from the excited compound nucleus of ^{265}105. Isotope yield, determined according to the branch of spontaneous fission, in the maximum of the excitation function corresponds to the $(5 \pm 1.5)\ 10^{-34}$ cm^2 cross section. (auth)

40615 (LA–4372) FISSION CROSS SECTION OF ^{237}Np FROM POMMARD. Brown, W. K.; Dixon, D. R.; Drake, D. M. (Los Alamos Scientific Lab., N. Mex.). Jan 1970. Contract W-7405-eng-36. 24p. Dep. CFSTI.

The ^{237}Np(n,f) cross section was measured from 32 eV to 2.2 keV and from 100 keV to 2.8 MeV. Energies of neutrons from the underground nuclear explosion Pommard were determined by time of flight from the source to the target foil located near the surface. Signals produced by fission fragments in solid-state detectors were recorded photographically. The ^{235}U(n,f) and ^{6}Li(n,α) reactions were used to measure the neutron flux. Grouped subthreshold resonances were observed. Above threshold, the cross section reached a maximum of about 1.7 b in the vicinity of 2.2 MeV. (auth)

40616 (NP–18288) THE K-CONVERSION COEFFICIENT OF THE 897-keV TRANSITION IN ^{207}Pb. Ahlesten, B.; Baecklin, A. (Forskningradens Laboratorium, Studsvik (Sweden)). 1970. 7p. (LF–26). Dep. CFSTI (U. S. Sales Only).

The K-conversion intensity and gamma intensity of the 897 keV transition in ^{207}Pb were measured, yielding a K-conversion coefficient of 0.019 ± 0.003, which is compatible with multipolarity M1 + <25% E2. (auth) (SW)

40617 (NYO-3938-3) STUDIES OF NUCLEAR FISSION, LOW-ENERGY NUCLEAR REACTIONS AND TRANSURANIC NUCLEI. Progress Report, June 1, 1969–June 1, 1970. Huizenga, John R. (Rochester Univ., N. Y. Dept. of Chemistry). Contract AT(30-1)-3938. 38p. Dep. CFSTI.

AMERICIUM-243—energy levels from plutonium-242 (α,t) and plutonium-242 (He-3,d) reactions, spectroscopic factors for, (E)
PLUTONIUM-242—neutron fission at 0.5 to 1.2 MeV, angular distributions of fragments from, (E)
URANIUM-235—energy levels of, calculation of spectroscopic factors using Coriolis matrix elements, (T)
URANIUM-236—photofission at 5.3 to 6.8 MeV, angular distributions of fragments from, (E)
URANIUM-237—energy levels from uranium-238 (He-3,α) reactions, (E)
URANIUM-238—helium-3 reactions (He-3,α) at 30 MeV, angular distribution for. (E) (J.W.R.)

40618 (RLO-1388-114) SPONTANEOUS FISSION ISOMERISM IN URANIUM ISOTOPES. Wolf, K. L.; Vandenbosch, R.; Russo, P. A.; Mehta, M. K.; Rudy, C. R. (Washington Univ., Seattle). Dec 1969. 18p. Dep. CFSTI.

A search for spontaneous fission isomerism in uranium and neptunium isotopes has resulted in the identification of a new isomer in ^{238}U with a half-life of 195 ± 30 nsec. A measurement of the half-life of previously reported ^{236m}U gives a value of 105 ± 20 nsec. Excitation functions were determined for the production of the spontaneous fission isomers of ^{236}U and ^{238}U by deuteron bombardment of ^{236}U and ^{238}U targets. Isomer ratios were also estimated. The low values of the isomer ratios and the failure to observe delayed fission in lighter uranium isotopes and in neptunium isotopes suggests that gamma decay may be the dominant mode of decay of shape isomers in this mass region. (auth)

40619 (RLO-2060-8) NUCLEAR CHEMISTRY PROGRESS REPORT, MARCH 15, 1969–MARCH 15, 1970. Loveland, Walter D. (Oregon State Univ., Corvallis). Contract AT(45-1)-2060. 25p. Dep. CFSTI.

BISMUTH-209—alpha fission at 35 MeV, cadmium-115 and cesium-134 isomer ratios in, (E/T)
CALIFORNIUM-252—fission of, γ-ray-fission fragment angular correlations from spontaneous, (E)
LITHIUM FLUORIDES—neutron chemical bonding to electrons in, search for
NEUTRONS—chemical bonding to electrons in lithium fluoride crystals, search for
NEUTRONS, THERMAL—chemical bonding to electrons in lithium fluoride crystals, search for
RADIUM-226—deuteron fission at 19 MeV, cadmium-115 and cesium-134 isomer ratios in, (E/T)
THORIUM-232—deuteron fission at 20 MeV, cadmium-115 and cesium-134 isomer ratios in
URANIUM-238—alpha fission at 35 MeV, cadmium-115 and cesium-134 isomer ratios in, (E/T) (J.W.R.)

40620 (WCAP-7365) STATUS REPORT FOR THE CURRENT EVALUATION OF MODIFIED ENDF/B REPRESENTATIONS FOR THE ISOTOPES OF PLUTONIUM: 239, 240, 241, AND 242. Eich, W. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Oct 1969. 177p.

The ENDF/B cross sectional representations for the four major plutonium isotopes were evaluated and modified on the basis of analysis both of critical experiments and expended fuel isotopic data. The effort involving critical experiments was made within the context of very extensive earlier work involving analysis of uranium lattices. The isotopic data were derived from Yankee expended fuel. Comparisons were made between analytic and experimental isotopic ratios. These comparisons simultaneously corroborated two modifications made on the basis of correlations with critical experiments and provided the rationale for an unique modification of the Pu-239 representation. Finally, a simple and economic approach for factoring the results of this work into design calculations was developed and verified. (auth)

40621 EXPERIMENTAL INFORMATION CONCERNING DEFORMATION OF NEUTRON RICH NUCLEI IN THE A ~100 REGION. Cheifetz, E.; Jared, R. C.; Thompson, S. G.; Wilhelmy, J. B. (Univ. of California, Berkeley). Phys. Rev. Lett.; 25: 38-43(6 Jul 1970).

Experimental results on the ground-state bands of light even-even nuclei produced in the primary fission of ^{252}Cf are presented. The systematics of the energy spacings and lifetimes are similar to those of deformed nuclei in the rare earth and actinide regions. (auth)

40622 EXCITED ROTATIONAL BAND IN SPHERICAL ^{150}Sm. Debenham, Philip; Hintz, Norton M. (Univ. of Minnesota, Minneapolis). Phys. Rev. Lett.; 25: 44-6(6 Jul 1970). (COO-1265-90).

Evidence is presented from the reaction ^{152}Sm(p,t)^{150}Sm for the existence of an excited rotational band based on the 1.256-MeV 0^+ state of ^{150}Sm, with 2^+ and 4^+ members at 1.417 and 1.819 MeV. (auth)

40623 BETA DECAY OF ^{187}W. Herman, A. W.; Heighway, E. A.; MacArthur, J. D. (Queen's Univ., Kingston, Ont.). Can. J. Phys.; 48: 1040-54(1 May 1970).

Coincidence studies have established in the decay scheme of ^{187}W the existence of transitions of energy 7, 36, 77, 455, 589, and 639 keV with intensities of 3.0 ± 0.5%, 0.50 ± 0.06%, 0.31 ± 0.07%, 0.05 ± 0.02%, 0.14 ± 0.04%, and 0.05 ± 0.02%, respectively, as well as yielding the absolute intensities of the well-known transitions in ^{187}Re. In addition the beta–gamma coincidence measurements have shown that (1) a first-forbidden unique transition feeds the first-excited state of ^{187}Re, (2) there is at most a very weak beta transition to the level at 512 keV, (3) there is no inner beta group of about 300 keV end-point energy and intensity 8% as indicated by several earlier investigations, and (4) the decay energy of ^{187}W to ^{187}Re is 1311 ± 2 keV. The relevance of these observations to the structure of ^{187}Re is discussed. (auth) (Canada)

40624 MEASUREMENT OF (n,2n) CROSS SECTION IN HEAVY NUCLEI. Winkler, G.; Hille, P. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber., Abt. II; 177: 313-30(1969). (In German).

Eleven nuclides, ^{140}Ce, ^{142}Ce, ^{160}Dy, ^{166}Er, ^{169}Tm, ^{170}Yb, ^{176}Hf, ^{182}W, ^{204}Hg, ^{203}Tl, and ^{204}Pb, were exposed to a 14.7-MeV neutron beam. The cross section of the (n,2n) reaction was determined and tabulated. Results are explained by means of a simple model for heavy nuclei. Significant shell effects were not observed. In the case of ^{142}Ce and ^{204}Hg the (n,3n) reaction was possible at the energies employed; however, emission of the third neutron did not occur consistently, although possible from an energy standpoint. (H.B.G.)

40625 FISSION CROSS SECTION MEASUREMENT ON ^{233}U. Cao, M. G.; Migneco, E.; Theobald, J. P.; Merla, M. (EURATOM, Geel, Belgium). J. Nucl. Energy; 24: 111-21(Jun 1970).

The cross section of the ^{233}U(n,f) reaction was measured for neutrons between 0.018 eV and 1.2 keV. A spark chamber fission fragment detector was used up to 80 eV and a fission neutron scintillator detector from 10 eV to 1.2 keV. A multilevel fit was performed for resonances below 65 eV. A comparison of the data with results of other laboratories is presented. (auth) (UK)

40626 BETA INSTABILITY IN ^{113}Cd. Greth, W. E.; Gangadharan, S.; Wolke, R. L. (Univ. of Pittsburgh). J. Inorg. Nucl. Chem.; 32: 2113-17(Jul 1970).

Evidence of beta instability was found in ^{113}Cd, the heavier of the last remaining pair of apparently stable odd-A isobars. An electrolytically refined and distilled sample of enriched ^{113}Cd metal was compared in an anticoincidence-shielded counter with a natural Cd metal "blank." A positive net counting rate was obtained, indicating with at least 96 percent certainty that ^{113}Cd is unstable. The counting efficiency was determined by counting ^{87}Rb samples of known disintegration rates. A half-life for ^{113}Cd of $(9.3 \pm 1.9) \times 10^{15}$ yr is assigned. (auth) (UK)

40627 NEW EXCITED STATES IN THE ^{140}Ce SEMI MAGIC NUCLEUS. Ardisson, Gerard; Marsol, Claire (Institut d'Etudes Nucleaires, Algiers). Compt. Rend., Ser. B; 270: 1249-52 (11 May 1970). (In French).

The ^{140}La decay was studied, using Ge(Li) spectrometers. Among the 33 gammas found, ten were new. The level scheme of ^{140}Ce is given; two new levels are proposed. (auth) (France)

40628 MASS-SPECTROMETRIC DETERMINATION OF THE HALF-LIFE OF ^{235}Np. Landrum, J. H. (Univ. of California, Livermore). J. Inorg. Nucl. Chem.; 32: 2131-2(Jul 1970).

A precise measurement of the half-life of ^{235}Np was made by a mass-spectrometric method, in which the isotopic ratio of ^{235}Np to ^{236}Np (long-lived isomer) was measured as a function of time. The apparent half-life, after 630 days, was 396.1 ± 1.2 days. (auth) (UK)

40629 INDEPENDENT YIELDS OF ^{80}Br, ^{82}Br, ^{129}I, AND ^{131}I FROM THE THERMAL NEUTRON FISSION OF ^{235}U, ^{239}Pu, ^{233}U, AND ^{237}Np. Tracy, B. L.; Thode, H. G. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 48: 1708-15(15 Jul 1970).

Absolute independent yields of the shielded nuclides ^{80}Br, ^{82}Br, ^{129}I, and ^{131}I produced in the thermal neutron fission of ^{235}U, ^{239}Pu, and ^{233}U were determined by careful mass spectrometric analyses

of krypton and xenon fission products. In addition, a fractional independent yield of ^{130}I from the thermal neutron fission of ^{238}Np has been determined, and an upper limit was set for the independent yield of ^{132}I from ^{235}U fission. All the yields from ^{235}U fission except that of ^{128}I are consistent with the Gaussian charge distribution described by Wahl. However, conventional theories of charge distribution in fission do not account for the irregular variation in iodine yields from one fissile nuclide to another. A mechanism based on differences in neutron emission probabilities from prompt fission fragments is proposed in order to explain this variation. (auth) (Canada)

40630 RESONANCE PARAMETER DETERMINATION OF THE MAIN RESONANCE OF RHODIUM BY THE MUTUAL-INDICATION METHOD. Fleck, Carl M. (Oesterreichische Hochschule, Vienna). Atomkernenergie; 15: 271-2(1970).

It could be shown for the main resonance of Rh that resonance parameters may be determined by means of the mutual-indication method with sufficient accuracy even without the use of a neutron spectrometer. The mutual-indication method was combined with the self-indication method, as suggested by Fleck and Weisshäupl to avoid variation of temperature or foil thickness. For this purpose, a suitable partner element for the mutual-indication had to be selected according to certain criteria. This was found to be ^{115}In which already had been investigated precisely by the self-indication method in earlier work. The temperature-corrected parameters of the first Rh resonance at 1.257 eV were found to be $\Gamma = (0.161 \pm 0.006)$ eV and $\sigma_\gamma = (5660 \pm 200)$ b. (auth)

40631 DECAY OF 17.7 MIN ^{120g}Sb AND 5.8 DAY ^{120m}Sb. Pan, P. J.; Hetherington, D. W.; McConnell, D. B.; Taylor, H. W. (Univ. of Toronto). Can. J. Phys.; 48: 1687-93(15 Jul 1970).

The decay of ^{120g}Sb and ^{120m}Sb was studied with a 33 cm^3 Ge(Li) detector and a multichannel analyzer. Through the use of coincidence techniques, excited states of ^{120}Sn were established at 1171.0, 1874.2, 2159.2, 2193.8, 2282.9, and 2479.6 keV. The results are compared to existing decay schemes for ^{120g,m}Sb and the theoretical predictions of contemporary nuclear models. (auth) (Canada)

40632 GENERALIZED NEUTRON PARTICLE-HOLE STATES IN THE N = ISOTONE ^{142}Nd. Mudersbach, K.; Heusler, A.; Wurm, J. P. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys.; A146: 477-96(1970).

Angular distributions for the inelastic proton decay of the two lowest isobaric analogue resonances in ^{143}Pm($J^\pi = \frac{1}{2}^-, \frac{3}{2}^-$) were measured. Proton decay widths and excitation energies for levels in ^{142}Nd between E_x = 3 MeV and 5 MeV are deduced. Most of the observed levels can be interpreted as generalized neutron particle-hole (GNPH) states, a concept to which physical significance has been given by a similar experiment on ^{140}Ce. Level spacings of the GNPH states as well as partial widths and angular distributions of decay protons from corresponding $J^\pi = \frac{1}{2}^-$ and $\frac{3}{2}^-$ resonances are found similar for the different N = 82 isotones. The wave functions of four prominent states in ^{142}Nd are determined in terms of GNPH configurations $|lj^{-1}, J^\pi\rangle$ with lj = $d_{\frac{5}{2}}$, $s_{\frac{1}{2}}$, $d_{\frac{3}{2}}$ and $J^\pi = \frac{1}{2}^-$ and $\frac{3}{2}^-$. The wave functions of these states are similar to those of corresponding states in ^{140}Ce. The spin splitting of the lowest GNPH configuration $|d_{\frac{5}{2}}^{-1}, \frac{1}{2}^-\rangle$ is identical for both N = 82 nuclei within the uncertainties of the analysis. This shows that the interaction among GNPH configurations depends only weakly on the number of protons. This fact is used to assign spins 1^- and 2^- to states containing appreciable amounts of the configuration $|s_{\frac{1}{2}}^{-1}, \frac{1}{2}^-\rangle$. (auth)

40633 ELECTRON CAPTURE DECAY OF ^{195}Hg AND ^{195m}Hg. Canty, M. J.; Barker, P. H.; Nguyen, T. D.; Connor, R. D. (Univ. of Manitoba, Winnipeg). Nucl. Phys.; A146: 523-48(1970).

The decay of 9.5 h ^{195}Hg and its 40 h isomer was studied using internal conversion and directional correlation spectrometers and solid-state detectors operated in singles and coincidence modes. The level structure of ^{195}Au reported in the recent literature is confirmed, while three new levels at 653 keV, 1250 keV and 1605 keV excitation and 27 additional γ-rays are suggested. Relative photon intensities of the new and previously accepted transitions were accurately measured with four independent Ge(Li) spectrometers. On the basis of absolute K- and L-shell internal conversion coefficients measured in a solid-state spectrometer, multipolarities of 22 γ-rays ranging in energy up to 1240 keV were assigned. Electron capture branching ratios and log ft values were inferred from the γ-ray and conversion coefficient data. On the basis of previously accepted spins and parities in ^{195}Au, five additional assignments were made: 242 keV ($\frac{3}{2}^+$), 525 keV ($\frac{1}{2}^-$), 894 keV ($\frac{5}{2}^-$), 1083 keV ($\frac{3}{2}^+$), 1111 keV ($\frac{5}{2}^+$). Parities of most of the remaining levels have been assigned and narrow ranges of possible spins suggested. Evidence is presented that low-lying excitations in ^{195}Au are describable by the core excitation model. (auth)

40634 PION EFFECTS IN ^{127}I(γ,xn) REACTIONS OF HIGH MULTIPLICITY. Jonsson, G. G.; Lindgren, K. (Univ. Lund, Sweden. Lund Inst. of Tech., Sweden). Nucl. Phys.; A141: 355-61(1970).

The yields of the reactions (γ,6n), (γ,7n), (γ,8n), and (γ,9n) in ^{127}I have been measured by activation analysis from their thresholds up to 900 MeV. The experimental mean cross sections above the pion threshold have been compared to theoretical calculations based upon a cascade-evaporation model and good agreement is found. (auth)

40635 DOUBLE INTERNAL BREMSSTRAHLUNG IN BETA DECAY OF ^{90}Y. Jastram, P. S.; Vanderleeden, J. C. (Ohio State Univ., Columbus). Phys. Rev., C; 1: 1036-41(Mar 1970).

The continuous coincidence γ-ray spectrum discovered in the process of searching for two-photon decay in ^{90}Zr is found to be double inner bremsstrahlung originating in the 2.26-MeV β decay of ^{90}Y to the ^{90}Zr ground state. The angular correlation, energy dependence, and total transition intensity of the coincidence spectra are compared with recent theoretical calculations. (auth)

40636 NUCLEAR CHARGE DISTRIBUTION IN FISSION: INDEPENDENT YIELDS OF ^{112}Ag, ^{134}I, AND ^{138}Cs FROM SPONTANEOUS FISSION OF ^{252}Cf. Troutner, D. E. (Univ. of Missouri, Columbia. Oak Ridge National Lab., Tenn.); Eichor, Matthew; Pace, Charles. Phys. Rev., C; 1: 1044-52(Mar 1970).

Independent yields of ^{112}Ag, ^{134}I, and ^{138}Cs from the spontaneous fission of ^{252}Cf are measured. These nuclides are separated from metal foils which are used as collectors for fission fragments recoiling from a one-microgram ^{252}Cf source and purified radiochemically. Independent yields are calculated from a knowledge of the activities of the nuclides as a function of separation time. The yields, expressed as fractional independent yields, are 0.009 ± 0.004, 0.26 ± 0.03, and 0.11 ± 0.03, ^{112}Ag, ^{134}I, and ^{138}Cs, respectively. Corresponding values of Z_P are 45.18, 52.14, and 53.82. These values differ from unchanged charge distribution by ~0.45 charge units in agreement with previously measured fractional cumulative yields from ^{252}Cf fission. (auth)

40637 LEVEL STRUCTURE OF ^{141}Ce FROM THE ^{140}Ce(n, γ) ^{141}Ce REACTION. Gelletly, W.; Moragues, J. A.; Marscotti, M. A. J.; Kane, W. R. (Brookhaven National Lab., Upton, N.Y.). Phys. Rev., C.; 1052-68(Mar 1970).

The level scheme of the ^{141}Ce nucleus is studied by observing the γ rays from the ^{140}Ce(n_{th}, γ) reaction at the Brookhaven high flux beam reactor. γ-ray singles and coincidence spectra are obtained with a 20-cm^3 Ge(Li) detector and a Ge(Li)-Ge(Li) combination. Thirty-two γ rays are assigned to ^{141}Ce and all but three of these γ rays are included in the ^{141}Ce level scheme. We have identified nine of these transitions as primary transitions from the neutron capture state to low-lying levels in ^{141}Ce. These primary transitions have the following energies (in keV) and relative intensities [I(662) = 100]; 4766.6 ± 0.5(48.0), 4291.4 ± 0.6(22.1), 3619.7 ± 0.6(4.0), 3435.0 ± 0.6(2.0), 3239.0 ± 1.5(2.7), 3092.5 ± 0.5(2.8), 3017.1 ± 0.7(4.7), 3003.3 ± 0.6(3.9), and 2905.9 ± 0.5(3.0). The data, together with the information available from earlier charged particle reaction and radioactive decay studies, establish levels in ^{141}Ce with energies 662.0 ± 0.1, 1137.0 ± 0.3, 1497.3 ± 0.4, 1808.7 ± 0.5, 1994.0 ± 0.6, 2189.6 ± 0.5, 2336.3 ± 1.0, 2410.8 ± 0.6, 2425.6 ± 0.8, and 2522.9 ± 0.6 keV. The measured neutron separation energy is 5428.6 ± 0.6 keV. All of these levels may be identified with levels observed earlier with lower accuracy in the ^{140}Ce (d, p)^{141}Ce reaction. As in the neighboring N = 83 nuclei ^{139}Ba and ^{143}Nd, there appears to be a correlation between the strengths of excitation of the $p_{\frac{3}{2}}$ and $p_{\frac{1}{2}}$ levels in the (n,γ) and (d,p) reactions The 1808.7-keV state, shown here to have $\frac{3}{2}^-$ spin and parity and not $\frac{1}{2}^-$ as previously believed, exhibits properties typical of a core excitation state formed from the coupling of an $f_{\frac{5}{2}}$ neutron to the first excited 2^+ state of the semimagic ^{140}Ce core. In particular, an E2 transition proceeds from this state to the $\frac{7}{2}^-$ ground state in competition with M1 transitions to the $\frac{5}{2}^-$ and $\frac{1}{2}^-$ first and second excited states. Accordingly, a calculation of the properties of the low-lying excited states in ^{141}Ce is carried out on the basis of the weak-coupling model. The results obtained are in reasonable agreement with the measured properties of the levels of ^{141}Ce. In particular, it is shown that the measured branching ratios of the transitions from the 1497.3- and 1808.7-keV levels are correctly predicted by this model. The level scheme of ^{141}Ce is compared with the level schemes of the other even-Z, N = 83 nuclei. (auth)

40638 STUDY OF THE NUCLEAR STRUCTURE EFFECT IN THE 161-keV TRANSITION OF ^{133}Cs. Meder, M. R. (Georgia State Univ., Atlanta). Phys. Rev., C; 1: 1085-93(Mar 1970).

The γ-γ, e_K-γ, and γ-e_K directional correlations are measured for the 276–161-keV cascade in ^{133}Cs. The γ-γ correlation is measured using two NaI(Tl) detectors, and also using NaI(Tl) to detect the 161-keV γ-ray and a cylindrical Ge(Li) to detect the

276-keV γ ray. The results of the measurements are $A_2(\gamma\text{-}\gamma) = -0.450 \pm 0.011$, $A_4(\gamma\text{-}\gamma) = -0.014 \pm 0.012$, for the first method, and $A_2(\gamma\text{-}\gamma) = -0.432 \pm 0.022$, $A_4(\gamma\text{-}\gamma) = -0.038 \pm 0.025$ for the second. The directional correlations involving conversion electrons are made using a surface-barrier detector and a NaI(Tl) detector. The results of these measurements are $A_2(e_K\text{-}\gamma) = -0.740 \pm 0.047$, $A_4(e_K\text{-}\gamma) = 0.047 \pm 0.042$, $A_2(\gamma\text{-}e_K) = -0.244 \pm 0.023$, and $A_4(\gamma\text{-}e_K) = 0.071 \pm 0.038$. In addition, the $K/(L + M + \ldots)$ ratio of the 161-keV transition has been measured with the result $K/(L + M + \ldots) = 4.0 \pm 0.3$. The γ-γ directional correlation agrees quite well with other measurements which are consistent with a spin sequence of $\frac{1}{2}^+$, $\frac{5}{2}^+$, $\frac{7}{2}^+$. The e_K-γ directional correlation is also in agreement with this spin sequence. The γ-e_K directional correlation is consistent with the γ-γ and e_K-γ measurements only if we use a theory which includes nuclear structure effects. The combination of $A_2(\gamma\text{-}e_K)$ and $K/(L + K + \ldots)$, when compared with nuclear-structure-dependent particle parameters and conversion coefficients, gives the most probable value of the ratio of the penetration matrix element to the normal γ-ray matrix element, $\lambda = 40 \pm 15$, for the 161-keV transition. (auth)

40639 DOUBLE K-SHELL IONIZATION IN THE DECAY OF ^{131m}Xe. Fischbeck, H. J.; Abdulla, A. A.; Petry, R. F. (Univ. of Oklahoma, Norman). Phys. Rev., C; 1: 1093-9(Mar 1970).

The deexcitation of the $h_{\frac{11}{2}}$ isomeric 164-keV level in ^{131m}Xe is reinvestigated for the possible simultaneous emission of two K-conversion electrons. The double-decay process is searched for by observing the x-ray coincidence spectrum with Ge(Li)-NaI(Tl) and Ge(Li)-Si(Li) coincidence spectrometers. Although the characteristic x ray of xenon is actually observed in the coincidence spectrum, it is found that this is not primarily due to the simultaneous emission of two K electrons. Our experiment places an upper limit on the possible occurrence of double K-electron emission per single-photon decay: $W_{eKeK}/W_\gamma < 1.4 \times 10^{-3}$. From the observed photon spectrum in coincidence with K x rays, an upper limit of 2×10^{-2} is obtained for the probability of e_K-γ transitions per single-photon decay. (auth)

40640 ISOBARIC ANALOG RESONANCES IN PROTON INELASTIC SCATTERING FROM ^{136}Xe. Moore, P. A. (Univ. of Texas, Austin); Riley, P. J.; Jones, C. M.; Mancusi, M. D.; Foster, J. L. Jr. Phys. Rev., C; 1: 1100-14(Mar 1970).

Thirty-six excited states of ^{136}Xe at excitation energies up to 6.3 MeV are observed in proton inelastic-scattering excitation-function measurements at proton energies from 9.77 to 12.89 MeV. The 2^+ first excited state at 1.30 MeV and the second excited state at 1.68 MeV resonate strongly at all of the lowest isobaric analog resonances, indicative of a collective nature for these states. Excitation functions for many of the remaining s states exhibit resonant behavior characteristic of neutron-particle-neutron-hole excited states. Proton inelastic angular distributions are measured at the lowest five analog resonances. Angular distributions for the particle-hole states at the first ($f_{\frac{5}{2}}$), second ($p_{\frac{3}{2}}$), and fourth ($f_{\frac{7}{2}}$) analog resonances are fitted to determine the hole structure of the particle-hole configurations. Using the results of this analysis in conjunction with the resonant behavior of the corresponding inelastic excitation functions, it is possible to determine particle-hole configurations and spin assignments for a number of excited states of ^{137}Xe. (auth)

40641 SENSITIVITY OF THE HALF-LIFE OF ^{90m}Nb TO CHEMICAL ENVIRONMENT. Olin, Arthur (Harvard Univ., Cambridge, Mass.). Contract Nonr-1866(56). Phys. Rev., C; 1: 1114-17(Mar 1970).

Changes in the decay constant of the isomer ^{90m}Nb are measured. It is found that $(\lambda_{Nb\ (fluoride\ complex)} - \lambda_{Nb})/\lambda_{Nb} = (-3.9 \pm 0.8) \times 10^{-2}$, $(\lambda_{Nb_2O_5} - \lambda_{Nb})/\lambda_{Nb} = (-1.9 \pm 0.5) \times 10^{-2}$. The Nb (fluoride complex) result confirms the value previously obtained by Cooper et al., which is questioned because of the negative result obtained by Weirauch et al. in a similar measurement. Some possible causes of this high sensitivity to chemical environment are discussed. (auth)

40642 LEVEL STRUCTURE IN ^{145}Eu. Newman, E. (Oak Ridge National Lab., Tenn.); Toth, K. S.; Auble, R. L.; Gaedke, R. M.; Roche, M. F.; Wildenthal, B. H. Phys. Rev., C; 1: 1118-25(Mar 1970).

Levels in ^{145}Eu are investigated by the ^{144}Sm(^{3}He, d) reaction and by the decay of 25-min ^{145}Gd. At the ^{3}He energy used, i.e., 40.33 MeV, the angular distributions for the stripping reaction are found to be highly structured. This fact permitted reliable assignments of transferred orbital angular momenta to the residual levels. Single λ-ray spectra for the decay of ^{145}Gd are measured with a 20-cm^3 Ge(Li) detector. The two sets of experimental data are then used to propose the following sequence of ^{145}Eu levels: 0 ($\frac{5}{2}^+$), 330.1 ($\frac{7}{2}^+$), 716 ($^{-11}/_2$), 808.4 ($\frac{1}{2}^+$), 1041.9 ($\frac{3}{2}^+$), 1599.9 ($\frac{7}{2}^+$), 1757.9 ($\frac{3}{2}^+$), 1844.7 ($\frac{3}{2}$, $\frac{5}{2}^+$), 1880.6 ($\frac{1}{2}$, $\frac{3}{2}^+$), 2112.0 ($\frac{3}{2}$, $\frac{5}{2}^+$), and a ($\frac{1}{2}^+$), ($\frac{3}{2}$, $\frac{5}{2}^+$) doublet at ~2480 keV. The salient features of this level scheme are that (1) the (^{3}He, d) reaction predominantly populates the first five energy levels, and (2) the decay from ^{145}Gd ($\frac{1}{2}^+$) proceeds mainly to the levels at 1757.9 and 1880.6 keV and not to the single-particle states at 808.4 and 1041.9 keV. The present results are compared with experimental systematics available for N = 82 isotones and with the implications of a recent shell-model calculation for nuclei in this region. (auth)

40643 DECAY OF 284-DAY ^{144}Ce, 17.3-MIN ^{144}Pr, AND A NEW ISOMER, 7.2-MIN ^{144m}Pr. Fasching, J. L.; Walters, W. B.; Coryell, C. D. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-905. Phys. Rev., C; 1: 1126-31(Mar 1970).

The half-life of the 59.03-keV 3^- level of ^{144}Pr is measured to be 7.2 ± 0.3 min. The decay schemes of ^{144}Ce and the isomers of ^{144}Pr are investigated using Ge(Li) detectors. From the results of the γ-ray studies, a (0.05 ± 0.03)% β-decay branch from ^{144m}Pr to the 3^- level at 1510 keV in ^{144}Nd is proposed. The γ-ray spectra and decay scheme of ^{144}Ce are in accord with the electron-conversion work of Geiger, Graham, and Ewan. (auth)

40644 ADDENDUM TO DELAYED NEUTRON EMISSION IN THE DECAYS OF SHORT-LIVED SEPARATED ISOTOPES OF GASEOUS FISSION PRODUCTS. Talbert, W. L. Jr. (Ames Lab., Iowa). Phys. Rev., C; 1: 1135-6(Mar 1970).

A correction is reported to the mass-formula predictions for the onset of delayed neutron emission using the formula of Garvey and Kelson. The predictions of the Garvey-Kelson and Seeger mass formulas are given for delayed-neutron-emission thresholds which have been recently reported in elements not included in the original report. (auth)

40645 GROUND-STATE QUASIROTATIONAL BANDS TO 8^+ IN $^{114-126}$Te PRODUCED BY (α, xn). Warner, R. A.; Draper, J. E. (Univ. of California, Davis). Phys. Rev., C; 1: 1069-84(Mar 1970).

Measurements of the γ spectra, time distributions, angular distributions, and excitation functions of γ rays from (α, 2n) and (α, 4n) reactions producing the vibrators $^{114-126}$Te reveal that the most prominent γ rays are in $8^+ \rightarrow 6^+ \rightarrow 4^+ \rightarrow 2^+ \rightarrow 0^+$ cascades. The energies and intensities exhibit remarkably regular systematics. (auth)

40646 STUDY OF THE (d,p) REACTION ON THE EVEN-A BARIUM ISOTOPES 130 TO 138. von Ehrenstein, D.; Morrison, G. C.; Nolen, J. A. Jr.; Williams, N. (Argonne National Lab., Ill.). Phys. Rev., C; 1: 2066-86(Jun 1970).

The (d,p) reactions on ^{130,132,134,136,138}Ba are investigated with 12.0-MeV deuterons from the Argonne Tandem Van de Graaff accelerator. Proton spectra are recorded in a broad-range magnetic spectrograph. Many new levels are observed. The ground-state Q values (in MeV) for the (d,p) reactions (including the odd-A targets) are found to be 5.269 for A = 130, 4.977 for A = 132, 4.746 for A = 134, 6.886 for A = 135, 4.680 for A = 136, 6.398 for A = 137, and 2.493 for A = 138. Proton angular distributions are measured for states up to an excitation energy of about 3 MeV. The observed angular momentum transfers are $l_n = 0$, 1, 2, 3, and 5, which correspond to the population of states of the $3s_{\frac{1}{2}}$ and $2d_{\frac{3}{2}}$ configurations below the closed neutron shell at N = 82 and the $2f_{\frac{7}{2}}$, $3p_{\frac{3}{2}}$, $3p_{\frac{1}{2}}$, $1h_{\frac{9}{2}}$, and $2f_{\frac{5}{2}}$ configurations above it. From the observed l values, it is possible to assign spins in some isotopes from a knowledge of the spin in other isotopes by taking account of systematic shifts in the Q values of levels and also from shell-model expectations. Distorted-wave Born-approximation calculations are used to extract absolute spectroscopic factors. The problems and uncertainties arising in such calculations are studied in some detail. They derive, in part, from the need to use a sharp radial cutoff to fit the experimental angular distributions; calculations with nonlocal potentials and finite-range approximations do not yield satisfactory fits. Another source of uncertainty is the dependence of the spectroscopic factors upon the geometric parameters of the bound-state potential well. The results are interpreted with the help of pairing theory; centers of gravity and single-particle energies are deduced. (auth)

40647 NUCLEAR EQUIPOTENTIAL SURFACES IN THE HEAVY ELEMENTS. Chasman, Richard R. (Argonne National Lab., Ill.). Phys. Rev., C; 1: 2144-51(Jun 1970).

The shifts of single-particle energy levels caused by distortions of nuclear equipotential surfaces are examined. Application of this approach is made to neutron single-particle states in the heavy-element region. Typical single-particle energy shifts are displayed in figures. The equipotential shapes studied in this paper are axially symmetric and are obtained by the replacement $\omega_0^2 r^2 \rightarrow \omega_\rho^2 \rho^2 + \omega_z^2 z^2 + \omega_\rho^2 (\rho^2 + z^2) G(z^2)$ with $G(z^2)$ of the form $G(z^2) =$

$e^{-Ar^2}\sum_n B_n(r^2t)^n$. A Woods–Saxon well is used for the central field, and eigenstates of the cylindrical harmonic oscillator ($|n_z,\lambda,n_r\rangle$) are used as a basis set in these calculations. ^{235}U is analyzed in detail. (auth)

40648 SPECTROSCOPIC STUDIES OF MOLYBDENUM ISOTOPES WITH (d,t) REACTIONS. Diehl, R. C.; Cohen, B. L.; Moyer, R. A.; Goldman, L. H. (Univ. of Pittsburgh). Phys. Rev., C; 1: 2132-43(Jun 1970).

The (d,t) reactions on ^{94}Mo, ^{96}Mo, and ^{100}Mo are studied with 17-MeV incident deuterons. The experimental angular distributions of the triton groups are compared with distorted-wave Born-approximation (DWBA) calculations to determine the l values and the spectroscopic factors. The I^π and excitation energy of the levels found in this study is compared with those from (d,p) reactions leading to the same final states. The occupation numbers and single quasiparticle energies are calculated and compared with previous results. (auth)

40649 PRODUCTION OF DECAY PROPERTIES OF THORIUM ISOTOPES OF MASS 221 TO 224 FORMED IN HEAVY-ION REACTIONS. Valli, Kalevi; Hyde, Earl K.; Borggreen, Joern (Univ. of California, Berkeley). Phys. Rev., C; 1: 2115-32 (Jun 1970).

In order to search for new neutron-deficient isotopes of uranium and thorium, targets of ^{209}Bi and ^{208}Pb are bombarded with beams of ^{22}Ne, ^{20}Ne, ^{19}F, ^{18}O, ^{16}O, ^{14}N, and ^{12}C in the Berkeley HILAC. The reaction products are transported from the reaction cell by the helium-jet technique and their α-disintegration characteristics measured by on-line techniques of α spectroscopy. Energy values, excitation functions, and half-lives of α-particle groups are measured. Only fragmentary evidence for uranium nuclei is found, because of intense losses by nuclear fission, but definite proof is obtained for the previously unknown millisecond isotopes ^{222}Th and ^{221}Th, and for their decay products ^{218}Ra, ^{214}Rn, ^{217}Ra, and ^{213}Rn. Improvements are made on the literature values for ^{223}Th and its decay products. The new α data help greatly in the determination of the trends in α-decay energies for isotopes of even-Z elements, particularly in the poorly defined region just above the 126 neutron shell. This allows the preparation of a more reliable set of predictions for many unknown nuclei. (auth)

40650 MOESSBAUER STUDY OF THE β DECAY OF ^{197}Pt WITH ORIENTED NUCLEI. Ehnholm, G. J. (Technical Univ. of Helsinki, Otaniemi, Finland); Katila, T. E.; Lounasmaa, O. V.; Reivari, P.; Kalvius, G. M. Phys. Rev., C; 1: 2109-14(Jun 1970).

The Mössbauer resonance in ^{197}Au is observed for a source of dilute Pt in Fe at temperatures between 0.06 and 20 K, obtained by employing a $^3He-^4He$ dilution refrigerator for cooling. At these low temperatures, the source nuclei are partially oriented because of the magnetic hyperfine interaction present in the alloy. The intensities of the observed hyperfine lines allow the determination of the polarization of the 77-keV first excited state in ^{197}Au, which is populated by β decay from the ^{197}Pt source. From this polarization, one can calculate the mixing ratio of the squares of the reduced matrix elements of different tensor rank present in the β transition. For the first-forbidden β decay of ^{197}Pt ($\Delta I = 0$, $\Delta\pi = -1$), we find the mixing ratio of rank-one elements to the rank-zero elements to be $\beta^2 = 7 \pm 1$. (auth)

40651 EMISSION OF PARTICLES OF $3 \le Z \le 8$ IN THE FISSION OF ^{252}Cf. Gazit, Yaacov (Israel Atomic Energy Commission, Yavne. Weizmann Inst. of Science, Rehovot, Israel); Nardi, Eran; Katcoff, Seymour. Phys. Rev., C; 1: 2101-8 (Jun 1970).

The energy spectra and yields of particles of $3 \le Z \le 8$ emitted in the spontaneous fission of ^{252}Cf are measured. The experiment is carried out using a particle telescope consisting of two dE/dx gas-filled proportional counters and a solid-state E counter. The cutoff energies are relatively low since essentially no absorber foil is placed between source and detector. The yields per 10^3 fission α particles are: Li, 2.9 ± 0.5; Be, 6.5 ± 0.7; B, 0.35 ± 0.10; C, 4.3 ± 0.9; N, $\ge 0.66 \pm 0.15$; O, $\ge 0.05 \pm 0.01$. Trajectory calculations are carried out for Li, Be, and C, and the initial conditions which give best agreement with the experimental results are obtained. (auth)

40652 CALCULATED COMPLETE-FUSION CROSS SECTIONS FOR 5 TO 10.5 MeV/amu ^{64}Ni, ^{86}Kr, AND ^{136}Xe PROJECTILES. Natowitz, Joseph B. (Texas A and M Univ., College Station). Contract AT-(40-1)-3924. Phys. Rev., C; 1: 2157-9(Jun 1970).

Cross sections for complete fusion of ^{64}Ni, ^{86}Kr, and ^{136}Xe projectiles with various targets are calculated as a function of the mass of the compound nucleus formed. Maximum complete-fusion cross sections of 200–300 mb are indicated for production of excited nuclei with $A \simeq 300$. (auth)

40653 SPONTANEOUS FISSION ISOMERISM IN URANIUM ISOTOPES. Wolf, K. L.; Vandenbosch, R.; Russo, P. A.; Mehta, M. K.; Rudy, C. R. (Univ. of Washington, Seattle). Phys. Rev., C ; 1: 2096-2101(Jun 1970).

A search for spontaneous fission isomerism in uranium and neptunium isotopes results in the identification of a new isomer in ^{238}U with a half-life of 195 ± 30 nsec. A measurement of the half-life of previously reported ^{236m}U gives a value of 105 ± 20 nsec. Excitation functions are determined for the production of the spontaneous fission isomers of ^{230}U and ^{239}U by deuteron bombardment of ^{236}U and ^{238}U targets. Isomer ratios have also been estimated. The low values of the isomer ratios and the failure to observe delayed fission in lighter uranium isotopes and in neptunium isotopes suggest that γ decay may be the dominant mode of decay of shape isomers in this mass region. (auth)

40654 NUCLEAR-STRUCTURE STUDIES WITH (d,t) REACTIONS ON ^{110}Pd, ^{108}Pd, AND ^{104}Ru. Diehl, R. C.; Cohen, B. L.; Moyer, R. A.; Goldman, L. H. (Univ. of Pittsburgh). Phys. Rev., C; 1: 2086-95(Jun 1970).

Seventeen-MeV deuteron-induced (d,t) reactions on ^{110}Pd, ^{108}Pd, and ^{104}Ru are used to complement (d,p) studies exciting the same final nuclei. Many new states are reported, and in several cases previous $I-\pi$ assignments are changed. The sum of spectroscopic factors gives roughly the same degree of filling as is found from the (d,p) work for the s and d states; further anomalous behavior is found for the $g_{\frac{7}{2}}$ and $h_{\frac{11}{2}}$ states. There is a tendency for the spectroscopic strength to be shifted to higher excitation energy in (d,t) reactions than in (d,p) reactions. There are strong similarities between the Pd and Ru isotopes as regards the number of nuclear states of each $I-\pi$ and the degree of filling of s and d states, but the $g_{\frac{7}{2}}$ state seems to be much less full in Ru than in Pd. In both Pd isotopes, there is a low-energy state (0.671 MeV in ^{110}Pd and 0.781 MeV in ^{108}Pd) excited by $l = 1$ transitions in both (d,p) and (d,t) reactions, indicating that they probably include components with 2p holes and 3p particles. (auth)

40655 $\gamma-\gamma$ DIRECTIONAL CORRELATIONS IN THE DECAY OF ^{125}Sb. Wyly, L. D.; Salzberg, J. B.; Patronis, E. T. Jr.; Kendrick, N. S.; Braden, C. H. (Georgia Inst. of Tech., Atlanta). Phys. Rev., C; 1: 2062-5(Jun 1970).

The $\gamma-\gamma$ directional correlations are measured for two cascades in the decay of 2.7-yr ^{125}Sb: 320–177 keV, $A_2 = -0.15(2)$, $A_4 = -0.04(4)$, $\sigma(177) = 0.9(+0.9, -0.4)$; 203–177 keV, $A_2 = -0.52(5)$, $A_4 = 0.02(5)$, $\sigma(203) = 1.0(+1.1, -0.4)$ for spin $1^1/_2$ assigned to the 525-keV level in ^{125}Te. The present results are inconsistent with spin $^5/_2$ for this level. (auth)

40656 CRYSTAL-BINDING EFFECTS ON DOPPLER BROADENING OF NEUTRON ABSORPTION RESONANCES. Borgonovi, G. M.; Houston, D. H.; Koppel, J. U.; Slaggie, E. L. (Gulf General Atomic, Inc., San Diego, Calif.). Phys. Rev., C; 1: 2054-9 (Jun 1970).

The line shape of the 6.65-eV neutron absorption resonance of ^{238}U is calculated for ^{238}U bound in a UO_2 lattice. The calculation uses the formalism of Nelkin and Parks, in which the line shape for a chemically bound nucleus is given in terms of an intermediate scattering function associated with slow-neutron scattering by the crystal. In previously published work, the intermediate scattering function is calculated from the distribution of normal-mode frequencies for the crystal. For a nonprimitive lattice like UO_2, however, it is necessary to use a normal-mode frequency distribution weighted by the squared moduli of polarization vectors describing the vibrations of the ^{238}U atoms. Significant errors in the line shape are shown to result if this weighted distribution is not used. The weighted distribution in the present calculation is based on the realistic lattice-dynamical model for UO_2 of Dolling, Cowley, and Woods; and the time integral in the Nelkin–Parks formalism is carried out directly by numerical procedures. The results thus provide essentially exact line shapes for the case of a relatively complicated chemically bound system of interest in reactor applications. Comparisons are made at 50 and 296°K between the exact results and common approximations used in line-shape calculations based on Lamb's weak-binding limit. (auth)

40657 ENERGY LEVELS OF ^{174}Lu. Jones, H. D.; Sheline, R. K. (Florida State Univ., Tallahassee). Phys. Rev., C; 1: 2030-45(Jun 1970).

Thirty-two levels in ^{174}Lu are observed up to an excitation energy of 1628 keV utilizing 12-MeV deuterons and the reaction $^{175}Lu(d,t)^{174}Lu$. The ground-state Q value is determined to be -1400 ± 15 keV. The spectrum is interpreted in terms of the coupling of the [404↓] Nilsson proton orbital with the neutron orbitals prominent in the (d,t) spectrum of ^{173}Yb. This interpretation results in the determination of relative energies due to the residual neutron–proton interaction for seven different configura-

tions. The observed singlet-triplet splitting energies for the [512↑], [521↑], and [521↓] neutron orbitals coupled to the [404↑] proton orbital are measured to be −110, +80, and −90 keV, respectively. Theoretical calculations of these energies made for a zero-range spin-dependent central potential give values of −106, +71, and −77 keV, respectively. The remarkable agreement indicates that the spin−spin interaction can account for most, if not all, of the singlet-triplet splitting energy. (auth)

Nuclear Theory

Refer also to abstracts 39737, 40171, 40202, 40221, 40410, and 40426.

40658 (AD-701380) THICK-TARGET BREMSSTRAHLUNG FROM ELECTRONS WITH AN ENERGY SPECTRUM AND AN ANGULAR DISTRIBUTION. Report for October 1968–June 1969. Ialongo, Gilberto (Aerospace Corp., El Segundo, Calif.). 30 Dec 1969. Contract F04701-69-C-0066. 44p. (TR-66(5260-20)-2; SAMSO-TR-70-32). CFSTI.

A formula for the bremsstrahlung radiation cross section from thick targets has been derived for monoenergetic electrons impinging normally on the absorber and has been extended to the case where electrons are allowed to have an energy spectrum and an angular distribution. The basic theory makes use of the Bethe−Heitler formula for thin targets and includes correlations for the absorption and buildup of photons, electron penetration in the target including multiple electron scattering, electron backscattering out of the target, electron energy loss in the target, and electron−electron bremsstrahlung. (auth) (USGRDR)

40659 (AD-702392) DATA ANALYSIS FOR ELECTRON–NUCLEAR DIFFERENTIAL SCATTERING CROSS SECTIONS. Fagg, L. W.; Bendel, W. L. (Naval Research Lab., Washington, D. C.). Dec 1969. 29p. (NRL-MR-2085). CFSTI.

A method is described which converts electron scattering data, obtained as the ratio of detector system counts to integrated beam current, into absolute differential cross sections. The method utilizes the characteristics of the apparatus, of the electron scattering process, and of the energy loss in the target. (auth) (USGRDR)

40660 (ANS-RPD-2) PROCEEDINGS OF THE TUTORIAL SESSION ON NUCLEAR MODELS. Presented at the 1969 Summer Meeting of the American Nuclear Society, Seattle, Washington, June 15, 1969. Vogt, Erich; Vandenbosch, Robert; Madsen, V. A. (American Nuclear Society, Hinsdale, Ill.). Mar 1970. 64p. (CONF-690609-25; CONF-690609-26; CONF-690609-27). Dep. CFSTI.

Separate abstracts were prepared for the three papers included. (J.W.R.)

For abstracts of individual papers see: 40661−40663.

40661 (ANS-RPD-2, pp 1-25) NUCLEAR MODELS AND NUCLEAR REACTIONS. Vogt, Erich (British Columbia Univ., Vancouver).

The use of various nuclear models in describing nuclear reactions is briefly reviewed. The compound nucleus picture and the optical model are examined in detail. Some recent advances in nuclear structure theory are discussed in connection with the interpretation of intermediate resonances in nuclear reactions. (J.W.R.)

40662 (ANS-RPD-2, pp 26-38) NUCLEAR MODELS AND NUCLEAR FISSION. Vandenbosch, Robert (Washington Univ., Seattle).

The experimental evidence for a double minimum in the potential energy surface associated with the deformation of fissioning nuclei is reviewed. The current success in explaining this complex potential energy surface as a shell correction to the liquid drop model is discussed. (J.W.R.)

40663 (ANS-RPD-2, pp 39-53) DIRECT-REACTION STUDIES OF NUCLEAR INELASTIC SCATTERING AND CHARGE EXCHANGE. Madsen, V. A. (Oregon State Univ., Corvallis).

The application of direct-reaction theory is made to nuclear inelastic scattering and charge-exchange reactions, particularly from the point of view of the microscopic model. The contribution of the particle-exchange mechanism is included, and a comparison of various reactions is made. The role of collective enhancement is discussed. Results of the theory are compared to experimental differential cross sections. (auth)

40664 (CONF-691208-(Vol.1)) PROCEEDINGS OF THE NUCLEAR PHYSICS AND SOLID STATE PHYSICS SYMPOSIUM, ROORKEE, DECEMBER 28-31, 1969. VOLUME I. INVITED TALKS. (Department of Atomic Energy, Bombay (India). Physics Committee). 1969. 148p.

Separate abstracts were prepared for five of the eight papers in Volume I. The remaining three papers are outside the scope of NSA. (J.W.R.)

For abstracts of individual papers see: 39620 and 40665−40668.

40665 (CONF-691208-(Vol.1), pp 3-12) NUCLEAR STRUCTURE STUDIES WITH ISOBARIC ANALOG RESONANCE REACTION. Mukherjee, P. (Saha Inst. of Nuclear Physics, Calcutta (India)).

A survey is made of a large number of recent investigations on the Isobaric Analog Resonance (IAR) work with (p,p) and (p,p′) reactions. The inherent simplicity of the analysis of the IAR data for the extraction of single neutron reduced widths is stressed, together with a comparison of the single particle stripping reaction results. The possibility of extracting information about the particle transfer mechanisms with the target in an excited state is also discussed. The structure of the particle hole states in ^{208}Pb and two hole one particle states in ^{207}Pb are derived from the (p,p′) data in IAR work. Important and new characteristics of the nature of the collective 3^- states in the Pb region are indicated from a comparative study of the gross resonance pattern. (auth)

40666 (CONF-691208-(Vol.1), pp 13-21) NUCLEAR STRUCTURE CALCULATIONS WITH REALISTIC NUCLEON–NUCLEON INTERACTIONS. Gunye, M. R. (Tata Inst. of Fundamental Research, Bombay (India)).

There are two main problems in nuclear structure calculations: (1) the derivation of an effective nucleon−nucleon (NN) interaction from the NN scattering data, and (2) the construction of a many-particle antisymmetrized wavefunction with good angular momentum and good isospin. The projection technique in conjunction with the variational formalisms has proved to be a reliable tool for solving the second problem at least for low-lying nuclear states. Some of the recent NN interactions were employed in multi-shell variational calculations to investigate the properties of the low-lying states of p-, sd-, and pf-shell nuclei. (auth)

40667 (CONF-691208-(Vol.1), pp 23-35) NUCLEAR MASSES AND DEFORMABILITIES. Ramamurthy, V. S. (Bhabha Atomic Research Centre, Bombay (India)).

The need for a nuclear mass formula which can predict not only the masses of nuclei in their ground state but also their dependence on a suitable set of generalized coordinates, describing a nucleus away from its stable equilibrium state is being felt in many new fields of investigations. Because of the complications involved in a proper calculation of nuclear masses based on a nuclear two body force, many attempts have been made in the last few years to develop a more phenomenological model whose parameters have been very well analyzed and understood. The recent developments in this direction are reviewed with particular reference to the Swiatecki−Strutinsky prescription that the observed systematics in nuclear masses can be understood in terms of a smooth behavior well represented by the semiempirical mass formula on which is superposed a local variation associated with nuclear shell effects. The droplet model developed by Myers is introduced for a systematic understanding of the functional form of the semiempirical mass formula and the significance of the various parameters entering the formula. An estimate of the shell correction to the masses can be made under the framework of the independent particle assumption following the method suggested by Strutinsky. The results of these calculations and the predictions are analyzed in the light of presently available experimental results. The inadequacies of the present models and possible improvements are also discussed. (auth)

40668 (CONF-691208-(Vol.1), pp 37-49) COUPLED-CHANNEL APPROACH TO THE ANALYSIS OF NUCLEAR REACTIONS. Ganguly, N. K. (Aligarh Muslim Univ. (India)).

Within the framework of a direct reaction process, Coupled Channel Reaction theory is discussed. Application of extended optical model is shown in the case of reaction channels which are single-particle excitations in closed shell nuclei. A particle-hole force acts as a residual interaction which couples such channels. Extended optical model analysis of the inelastic scattering of particles from vibrational and rotational nuclei and the solutions of the coupled equations are discussed. The results of analysis of the inelastic scattering of protons are discussed. (auth)

40669 (ITF-70-13) ROTATIONAL BANDS CONSTRUCTED ON THE OCTUPOLE VIBRATIONS. Dzyublik, A. Ya. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 24p. (In Russian). Dep. CFSTI (U. S. Sales Only).

To describe the properties of odd rotational bands observed in some even–even nuclei the adiabatic nonaxial rotator model is used. The rotational energies and ratios of reduced probabilities of E1 transitions between the rotational bands of opposite parity and E2 transitions within the bands of negative parity are calculated. (auth)

40670 (LA–4329) CALCULATION OF SINGLE-PARTICLE LEVELS IN A DEFORMED DIFFUSE WELL. Ford, G. P.; Hoffman, D. C.; Rost, E. (Los Alamos Scientific Lab., N. Mex.). Nov 1969. Contract W-7405-eng-36. 109p. Dep. CFSTI.

Energy levels for spherical and deformed Woods–Saxon potentials with a Thomas-type spin-orbit coupling have been calculated for prolate deformations at intervals of 0.05 in β up to $\beta = 0.5$. Level diagrams for neutrons are presented in the $139 \leq A \leq 191$ and $219 \leq A \leq 313$ regions. Level diagrams for protons are given for all odd Z's in the regions $57 \leq Z \leq 77$ and $85 \leq Z \leq 109$, for the same masses. Some additional proton cases were calculated for constant A to show the Coulomb and symmetry-energy dependence. The potential parameters, r_0, V_0, α, and λ, were chosen to give the best agreement with the known ground-state level assignments in these regions. Energies were obtained as eigenvalues of matrices representing the Hamiltonian in terms of truncated sets of spherical basis functions. (auth)

40671 (LA–4349) RELKIN: A TWO-BODY RELATIVISTIC KINEMATICS CODE. Davidson, J.; Jarmie, N.; Niethammer, A. (Los Alamos Scientific Lab., N. Mex.). 18 Dec 1969. Contract W-7405-eng-36. 8p. Dep. CFSTI.

RELKIN, a two-body relativistic kinematics code written in FORTRAN IV, is useful in analyzing reactions of the general form A + B = C + D by calculating kinematic quantities for a set of energies (or momenta), each energy containing a range of laboratory (or center-of-mass) angles of one of the outgoing particles; photoproduction and two-body decay are handled as special cases. (auth)

40672 (RPI–3947-9) NEUTRON AND GAMMA-RAY EMISSION FROM HIGHLY EXCITED STATES AND STATES WITH HIGH SPIN. Annual Progress Report, June 1, 1969–May 31, 1970. Sperber, Daniel (Rensselaer Polytechnic Inst., Troy, N. Y.). Mar 1970. Contract AT(30-1)-1955. 11p. Dep. CFSTI.

The decay of highly excited states and high-spin states was studied with special attention given to neutron evaporation in heavy-ion reactions, population of rotational states in (α,xn) reactions, isomer ratios, and angular distributions. The studies are based on the compound nucleus statistical model. Some results on the angular distributions of protons in the $^{63}Cu(^{12}C,p)$ and $^{56}Fe(\alpha,p)$ reactions are presented. (J.W.R.)

40673 ROLE OF EXCHANGE FORCES IN NUCLEAR DEFORMATION. Volkov, A. B. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A141: 337-54(1970).

The direct and exchange potential matrix elements are shown to be either insensitive to nuclear deformation or to have opposing behavior. Therefore, the total potential energy behavior as the system deforms depends rather sensitively on the exchange properties of the nuclear force. Reasonable saturating forces which are related to scattering data result in exchange mixtures which make the total potential energy insensitive to reasonable deformations. The minimization of the total energy (essentially the kinetic energy) leads to results similar to the Nilsson model. The ^{24}Ne nucleus and the 4p–4h ^{16}O excited state are used as illustrations. (auth)

40674 DEUTERON WAVE FUNCTIONS FOR THE HAMADA–JOHNSTON POTENTIAL. Humberston, J. W.; Wallace, J. B. G. (University Coll., London). Nucl. Phys.; A141: 362-8(1970).

A series of analytic approximations to the deuteron wave function is obtained for a slightly modified and an unmodified Hamada–Johnston potential. These two potentials give 2.226 MeV and 2.269 MeV, respectively, for the deuteron binding energy. (auth)

40675 NUCLEAR SHAPE AND ROTATION. Wakai, Masamiti (Japan Atomic Energy Research Inst., Ibaraki). Nucl. Phys.; A141: 423-30(1970).

The effect of the rotation on the nuclear shape is investigated. Both the antipairing and the centrifugal stretching effects are considered, on the basis of the cranking model. The numerical calculation is performed for six nuclei in the rare-earth region. It is found that for all six nuclei the equilibrium deformation increases with the spin in a low-spin region and the change of the deformation does not have a great influence on the rotational spectra. But in a high-spin region the equilibrium deformation does not always increase with the spin. In the cases of four nuclei the equilibrium deformation decreases with the spin and several minima appear on the energy surface. (auth)

40676 RPA PAIRING CORRELATION IN THE GROUND STATE AND THE FAVORED ALPHA DECAY OF EVEN–EVEN DEFORMED NUCLEI. Mihu, Razvan V. (Univ., Bucharest). Rev. Roum. Phys.; 15: 117-20(1970).

The favored α intensities are obtained using different correlated vacuums for the ground state of the parent and daughter nuclei, respectively. This new vacuum is correlated by a pairing vibration. (L.T.W.)

40677 OFF-SHELL CONTINUATION OF THE TWO-NUCLEON TRANSITION MATRIX WITH A BOUND STATE. Haftel, M. I. (Naval Research Lab., Washington, D. C.). Phys. Rev. Lett.; 25: 120-2(13 Jul 1970).

A method of continuing the two-nucleon transition matrix off the energy shell for bound-state, partial-wave eigenchannels is presented. The arbitrary parmeters of this method are a symmetric function of momentum $\sigma_W(k,k')$ and the bound-state wave function $\Psi_B(r)$. The phase-shifts are essentially contained in $\sigma_W(k,k)$. While a potential is presumed to be present, it never explicitly appears in determining the T matrix. (auth)

40678 MULTICONFIGURATION FIELD THEORY IN NUCLEI. Satpathy, L.; Ho-Kim, Q. (Univ. Laval, Quebec). Phys. Rev. Lett.; 25: 123-5(13 Jul 1970).

The multideterminant nuclear wave function has been used to derive a system of coupled equations for the particle orbitals and the configuration-mixing coefficients to be solved self-consistently by iterations. To illustrate the procedure, ^{26}Mg has been considered. Compared with the Hartree–Fock solution the results show many significant differences and are energetically more favorable. (auth)

40679 E0 ADMIXTURE DETERMINATION BY GAMMA–GAMMA DIRECTIONAL CORRELATION MEASUREMENTS. Anicin, I.; Krmpotic, DJ.; Kukoc, A.; Vukanovic, R. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Nucl. Instrum. Methods; 83: 293-4(1970).

A method for E0 admixture determination by $\gamma-\gamma$ correlation technique is proposed. Explicit expressions for $A_{kk}^{1-3}(\gamma,\gamma)$ correlation coefficients are derived, and sensitivity of the method discussed. (auth)

40680 ONE- AND THREE-QUASI-PARTICLE PROJECTED STATES FOR ODD-MASS NUCLEI WITH A MAJOR CLOSED SHELL. Ottaviani, P. L. (Univ., Trieste, Italy); Savoia, M. Nuovo Cim.; 67A: 630-40(21 Jun 1970).

The formalism of the "projected states" is generalized to the odd-mass nuclei which can be treated as identical nucleon systems. The idea consists in picking out from the one- and three-quasi-particle states the components with a fixed particle number. The nuclear Hamiltonian is then diagonalized in the Hilbert space spanned by these components. Using this model the correct level sequence of ^{117}Sn is reproduced. The force and the parameters are the same as those used in a previous paper to fit the experimental data of the even isotopes starting from the appropriate projected model. (auth)

40681 AUTOMATIC SEARCH CODE FOR NUCLEAR OPTICAL MODEL. Wada, Takeshi (Inst. of Physical and Chemical Research, Saitama, Japan). Rikagaku Kenkyusho Hokoku; 46: No. 2, 21-33(Mar 1970). (In Japanese).

The optical model calculation is now used as a standard method for the analysis of elastic scattering. Here an improved automatic parameter search code "SEARCH" was made to analyze the scattering of heavy ions as well as that of light particles. Many calculations were done to test the code and some results are presented. The experimental data which had been obtained by IPCR cyclotron were analyzed by this code. The results of these analyses and also the applicability and limitation of the optical model were discussed. Further, the effects of well known parameter ambiguity on DWBA calculation were examined. (auth)

40682 THE HYPERSPHERICAL EXPANSION APPROACH TO NUCLEAR BOUND STATES. II. Calogero, F. (Inst. of Theoretical and Experimental Physics, Moscow. Istituto Nazionale di Fisica Nucleare, Rome); Simonov, Yu. A. Nuovo Cim.; 67A: 641-57(21 Jun 1970).

The hyperspherical expansion approach to nuclear bound states is described. The extension of the case of velocity-dependent forces of previous results, in which upper bounds were obtained for the lower-energy levels of (suitably defined) doubly magic nuclei, is reported. (auth)

40683 THE VALIDITY OF THE SUDDEN APPROXIMATION AS APPLIED TO DEUTERON STRIPPING. Baker, T. F.; Goldfarb, L. J. B. (Univ. of Manchester, Eng.). Nucl. Phys.; A146: 577-96(1970).

A numerical study is made of the recent formulation of deuteron stripping by Butler et al. which is based on the use of the sudden approximation. Fits to experiment are generally very poor and the deduced spectroscopic factor shows a marked dependence on the deuteron energy. Some improvement is noted for deuterons in the 150-MeV region where the sudden approximation is expected to show more validity. (auth)

40684 PARTICLE-GAMMA ANGULAR CORRELATIONS FOLLOWING NUCLEAR REACTIONS. Rybicki, F. (Univ. of Texas, Austin); Tamura, T.; Satchler, G. R. Nucl. Phys.; A146: 659-76(1970).

The general theory of the b-γ angular correlation in the reaction sequence A(a, b)B(γ)C is reviewed with particular attention to the phase conventions being used. Some examples are given of the correlations predicted by direct interaction theory following the excitation of one- and two-phonon-like states in medium weight even nuclei by the inelastic scattering of protons. (auth)

40685 SOME ACCURATE NUMERICAL SOLUTIONS FOR THREE-BODY SYSTEMS WITH CENTRAL LOCAL POTENTIALS. Bell, D. H. (Univ. of Sussex, Eng.); Delves, L. M. Nucl. Phys.; A146: 497-513(1970).

Variational solutions are presented for a number of simple three-body states with central local potentials. Those considered include the ground and excited states of three bosons, for potentials with and without hard cores; the trineutron; and the $T = \frac{1}{2}$ state in the triton with central forces. In each case the calculations are carried far enough to demonstrate explicitly convergence of the upper bound to an accuracy of approximately four significant figures. In addition lower bounds are provided which lie extremely close to these upper bounds. (auth)

40686 EIGENVALUE PROBLEM FOR COLLECTIVE MOTION IN THE RANDOM PHASE APPROXIMATION. Chi, Benjamin E. (State Univ. of New York, Albany). Nucl. Phys.; A146: 449-56 (1970).

The random phase approximation yields a description of collective nuclear excitation in terms of an eigenvalue problem involving a non-hermitian matrix. It is shown that there exists a related hermitian matrix H, satisfying the standard eigenvalue problem Hs = hs, whose solution directly yields the solution of the original problem. (auth)

40687 ON THE MATTER DISTRIBUTION IN NUCLEI CALCULATED FROM THE DEFORMED SINGLE-PARTICLE MODEL. Nilsson, Bjoern (Lund Inst. of Tech., Sweden). Nucl. Phys.; A146: 457-64(1970).

Parameters of the proton and neutron distributions in heavy, deformed nuclei are calculated by using a deformed single-particle model. It is found that the values of the surface thickness determined from the model chosen are about 35% too large compared to experimental data. (auth)

40688 INFLUENCE OF NON-MARKOFFIAN RELAXATION PROCESSES ON TIME-INTEGRAL PERTURBED ANGULAR CORRELATIONS. Gabriel, H. (Univ., Berlin). Phys. Lett., A; 32: 202-3(9 Jun 1970).

A relaxation theory, not restricted to $\tau_c \ll \tau_m$, is applied to integral perturbed angular correlations assuming that the damping effects are due to magnetic interactions. (auth)

40689 COMPARISON OF SOME DEUTERON WAVE FUNCTIONS. Peltola, E. I.; Laurikainen, K. V.; Kouki, T. (Univ. of Helsinki). Soc. Sci. Fenn., Comment. Phys.-Math.; 36: No. 6, 87-94(1969).

Deuteron wave functions given by Hamada and Johnston, Reid, and Peltola are compared with each other and with experimental data. In this comparison the deuteron ground state, photodisintegration of the deuteron and elastic electron-deuteron scattering are considered. The influence of different deuteron models on the neutron form factors is also investigated. The results seem to indicate that the triplet even potential in the deuteron must also contain a hard core or some other kind of repulsion. (auth) (Finland)

40690 ISOSPIN IN NUCLEAR PHYSICS. Wilkinson, D. H. (ed.). New York; John Wiley and Sons, Inc. (1969). 757p. $43.50.

Each of the 13 chapters included is individually abstracted. (L.W.A.)

For abstracts of individual chapters see: 40691–40703.

40691 CHARGE INDEPENDENCE AND CHARGE SYMMETRY OF NUCLEAR FORCES. Henley, Ernest M. (Univ. of Washington, Seattle). pp 15-72 of Isospin in Nuclear Physics. /Wilkinson, D. H. (ed.). New York; John Wiley and Sons, Inc. (1969).

Evidence for and corrections to charge independence and charge symmetry of nuclear forces are presented. Relevant developments are briefly reviewed, and the necessary formalism is set up. (L.W.A.)

40692 NUCLEAR SYMMETRIES. Elliott, J. P. (Univ. of Sussex, Brighton, Eng.). pp 73-113 of Isospin in Nuclear Physics. /Wilkinson, D. H. (ed.). New York; John Wiley and Sons, Inc. (1969).

Symmetry is discussed, with illustrations in atomic as well as nuclear physics. Isospin is presented as a reasonably exact symmetry, and other approximate symmetries are described. The important concepts and results of group theory are described. (L.W.A.)

40693 ISOSPIN IN NUCLEAR β-DECAY. Blin-Stoyle, R. J. (Univ. of Sussex, Brighton, Eng.). pp 115-72 of Isospin in Nuclear Physics. /Wilkinson, D. H. (ed.). New York; John Wiley and Sons, Inc. (1969).

The experimental and theoretical establishment of the isospin structure of β-decay interaction and the use of the isospin structure to deduce information about the working of charge dependent phenomena in the nucleus are discussed. A brief review of standard β-decay theory is presented. (L.W.A.)

40694 THE ROLE OF ISOSPIN IN ELECTROMAGNETIC TRANSITIONS. Warburton, E. K.; Weneser, J. (Brookhaven National Lab., Upton, N. Y.). pp 173-228 of Isospin in Nuclear Physics. /Wilkinson, D. H. (ed.). New York; John Wiley and Sons, Inc. (1969).

Isobaric multiplets, which have expanded the role of isospin in the interaction of nuclei with electromagnetic fields from the charge-symmetry concept to the full isospin invariance concept, are discussed. The selection rules for electromagnetic transitions with isospin formalism, along with tests and applications of them, are presented. The emphasis for the applicability of the isospin concept is on light nuclei. (L.W.A.)

40695 ISOSPIN PURITY OF LOW-LYING NUCLEAR STATES. Soper, J. M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 229-58 of Isospin in Nuclear Physics. /Wilkinson, D. H. (ed.). New York; John Wiley and Sons, Inc. (1969).

Isospin impurity is discussed via the shell-model and the two-fluid hydrodynamical model. The Coulomb interaction between protons, the primary source, and nuclear interactions are presented as sources of isospin impurity. Isobaric spin mixing in heavy nuclei is mentioned. (L.W.A.)

40696 ISOSPIN DISTRIBUTIONS IN NUCLEI. French, J. B. (Univ. of Rochester, N. Y. Univ., Mexico, Mexico City). pp 259-95 of Isospin in Nuclear Physics. /Wilkinson, D. H. (ed.). New York; John Wiley and Sons, Inc. (1969).

General isospin effects in nuclear spectra and strength distributions are discussed through the use of a formal treatment containing a density operator and sum rule methods. The role of isospin in nuclear configuration structures and in single-particle and single-hole excitations is presented. (L.W.A.)

40697 SYSTEMATICS OF COULOMB ENERGIES AND EXCITATION ENERGIES OF ISOBARIC ANALOGUE STATES. Jaenecke, Joachim (Univ. of Michigan, Ann Arbor). pp 297-387 of Isospin in Nuclear Physics. /Wilkinson, D. H. (ed.). New York; John Wiley and Sons, Inc. (1969).

General features of Coulomb energies such as the A-, T-, Z-, and N-dependence of a large group of nuclei are discussed. The isobaric multiplet mass equation, a shell model description of Coulomb energies for light nuclei, a description of Coulomb displacement energies in heavy nuclei, Coulomb energy relationships, and excitation energies of isobaric analog states are presented and discussed. (L.W.A.)

40698 ISOSPIN DEPENDENCE OF OPTICAL MODEL POTENTIALS. Satchler, G. R. (Oak Ridge National Lab., Tenn.). pp 389-460 of Isospin in Nuclear Physics. /Wilkinson, D. H. (ed.). New York; John Wiley and Sons, Inc. (1969).

Isospin effects in the optical model description of the scattering of projectiles by a nucleus are discussed. The simple isovector interaction in the optical model is described for nucleons and mass-3 nuclei. Evidence is reviewed for isospin dependence of the shell model potential for bound single particle states. (L.W.A.)

40699 THEORY OF NUCLEON INDUCED ANALOGUE RESONANCES. Robson, D. (Florida State Univ., Tallahassee). pp 461-508 of Isospin in Nuclear Physics. /Wilkinson, D. H. (ed.). New York; John Wiley and Sons, Inc. (1969).

Analog resonances are described in terms of general nuclear reaction theory. The use of Bloch's boundary condition operator, $\mathcal{L}$, a qualitative discussion of the use of model Hamiltonians, and the use of shell model formalism in relation to analog resonances are presented. The extracting of spectroscopic factors from analog resonance data, the interpretation of polarization and angular correlation phenomena via analog resonances, and the isospin forbidden decay of analog resonances are discussed. Future developments of analog resonances are briefly mentioned. (L.W.A.)

40700 FINE STRUCTURE IN ANALOGUE STATES. Lane, A. M. pp 509-90 of Isospin in Nuclear Physics. /Wilkinson, D. H. (ed.). New York; John Wiley and Sons, Inc. (1969).

Fine structure in analog states is discussed as an aspect of line-broadening. The gross structure situation and line broadening of bound and unbound states are presented. (L.W.A.)

40701 ELECTROMAGNETIC DECAY OF ISOBAR ANALOGUE STATES. Hanna, Stanley S. (Stanford Univ., Calif.). pp 591-664 of Isospin in Nuclear Physics. /Wilkinson, D. H. (ed.). New York; John Wiley and Sons, Inc. (1969).

The electromagnetic decays of isospin states formed as resonances in nuclear reactions are examined. In order to determine spectroscopic information contained in experimental data and its contribution to an understanding of nuclear structure, a development based on the type of nucleus, the multipole character of the radiation, and the isospin assignment of the level is presented. Experimental data presented include positions of levels, quantum numbers, the radiative transition matrix elements, and the ratio and relative phase of the matrix elements. (L.W.A.)

40702 ISOSPIN IN TRANSFER REACTIONS. Schiffer, J. P. (Univ. of Rochester, N. Y.). pp 665-92 of Isospin in Nuclear Physics. /Wilkinson, D. H. (ed.). New York; John Wiley and Sons, Inc. (1969).

Isospin effects in transfer reactions—both the spectroscopic factor and the reaction mechanism—are discussed. (L.W.A.)

40703 ISOBARIC ANALOGUE RESONANCES AND NUCLEAR SPECTROSCOPY. Temmer, G. M. (Rutgers-The State Univ., New Brunswich, N. J.). pp 693-738 of Isospin in Nuclear Physics. /Wilkinson, D. H. (ed.). New York; John Wiley and Sons, Inc. (1969).

The use of the study of isobaric analog resonances to obtain nuclear spectroscopic information is discussed. The interpretation of inelastic proton scattering which proceeds through isobaric analog resonances in the compound nucleus is presented. (L.W.A.)

40704 FISSION PROCESS. Strutinsky, V. M. (Univ. of Copenhagen). Riv. Nuovo Cim.; 1: Special No., 442-59(1969).

From Conference of the European Physical Society, Florence, Italy. See CONF-690421.

The early development in the theory of the fission process is reviewed. The success in the liquid-drop model in describing the fission barrier as well as nuclear masses is discussed. Recent discoveries of complex structure in the fission process which cannot be explained by the phenomenological liquid-drop model are described in detail. The current theories used to describe the intermediate structure in fission are surveyed. (J.W.R.)

40705 ROTATIONAL DESCRIPTION OF STATES IN CLOSED- AND NEAR-CLOSED-SHELL NUCLEI. Mariscotti, M. A. J. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 24: 1242-5(1 Jun 1970).

All ground-state bands observed in even-even nuclei, including closed-shell nuclei, are accurately predicted by a two-parameter description based on the cranking model. A hitherto unobserved discontinuity in a plot of E(I)/E(2) vs E(4)/E(2) is also predicted by the model. (auth)

40706 VACUUM RECOIL CORRECTION TO DOPPLER SHIFT ATTENUATION MEASUREMENTS. Robertson, B. C. (Univ. of Alberta, Edmonton). Nucl. Instrum. Methods; 84: 1-3(1970).

The correction to Doppler shift attenuation measurements due to vacuum recoils is calculated for the case that the target also serves as stopping material. The correction is shown to depend on the recoil range, the target thickness, and the nuclear lifetime. (auth)

40707 THEORETICAL STUDY OF 1^+ AND 3^+ STATES IN EVEN-A NICKEL ISOTOPES. Rustgi, M. L.; Roy, B. Barman; Raj, R. (State Univ. of New York, Buffalo). Phys. Rev., C; 1: 1138-41(Mar 1970).

Employing the effective matrix elements of Kuo and Brown, of Auerbach, and of Cohen et al., the low-energy 1^+ and 3^+ levels in even-A nickel isotopes are studied within the framework of the modified Tamm-Dancoff approximation. Their properties and reduced transition rates are examined. (auth)

40708 OBSERVATION OF NONLOCAL EFFECTS IN NUCLEAR SCATTERING. Monahan, J. E. (Argonne National Lab., Ill.); Thaler, R. M. Phys. Rev., C; 1: 1924-8(Jun 1970).

The question of how nonlocal effects might be observed in elastic scattering is investigated under the assumption that the interaction is describable by a Hamiltonian. The energy dependence of the real part of the forward-scattering amplitude is related to a dynamic quantity with dimensions of length, which is referred to as the nonlocal distance. Possible off-energy-shell effects can be discussed in terms of this nonlocal distance. (auth)

40709 FORWARD SCATTERING AMPLITUDE WITH NUCLEAR CORRELATIONS AND OVERLAPPING POTENTIALS. Kohmura, Toshitake (Univ. of Rochester, N. Y.). Phys. Rev., C; 1: 1945-54(Jun 1970).

A theory of nuclear scattering is presented for overlapping potentials between the incident particle and each of the target nucleons, without using the impact-parameter approximation of Feshbach. As the nuclear internal Hamiltonian is important for the overlap in the potentials, included in the energy denominators is a term which is dependent on the nuclear internal Hamiltonian, as well as the term which is linear in the momentum transfers. A correction to the Glauber model, due to the overlap in the potentials, is obtained from the principal part of the denominators. The correction reduces both the total cross section and the forward differential cross section by about 15%. The "effective solid angle for scattering" is defined to be the total cross section divided by the forward differential cross section. From this quantity the nuclear correlation is determined independently of the correction due to the overlap in the potentials. Range parameters for nuclear correlation functions are obtained from existing data. (auth)

40710 BETA–GAMMA–GAMMA DIRECTION-CORRELATION FUNCTION FOR TWO-PHOTON RADIATION EMITTED DURING ALLOWED BETA DECAY. Mulligan, B.; Seyler, R. G. (Ohio State Univ., Columbus). Phys. Rev., C; 1: 1041-3(Mar 1970).

Two Feynman diagrams for double internal bremsstrahlung are evaluated for an allowed β decay. The nucleons are treated nonrelativistically, and Coulomb effects are not considered. (auth)

40711 $^{16}O(p,d)^{15}O$ FORM FACTORS. Preedom, B. M.; Snelgrove, J. L.; Kashy, E. (Michigan State Univ., East Lansing). Phys. Rev., C; 1: 1132-5(Mar 1970).

Two methods of obtaining distorted-wave form factors which provide fits to the $^{16}O(p, d)$ reaction are investigated. Both apply a radial damping term to a Woods-Saxon eigenfunction. One method employs a correction for the density dependence of the interaction along with the usual local-energy-approximation correction terms for nonlocality and finite range. The other method applies a simple empirical two-parameter damping term. The calculations are compared with data for $1p_{\frac{1}{2}}$ and $1p_{\frac{3}{2}}$ neutron transfers at energies from 25 to 45 MeV. (auth)

40712 NUCLEAR DISTORTION EFFECTS ON THE EMITTED PION IN PHOTO-PION REACTIONS. Devanathan, V. (Univ. of Madras). Symp. Theor. Phys. Math.; 10: 123-7(1970).

From Symposia on Theoretical Physics and Mathematics, Madras, India. See CONF-690125.

A method is outlined for taking into account the nuclear distortion effects on the emitted pion in photoproduction reactions on nuclei. The particular reaction $\gamma + {}^{16}O \rightarrow \pi^+ + {}^{16}N$ is considered, although the results apply to all nuclei. (J.F.P.)

40713 MODIFIED ALAGA RULES FOR ALLOWED BETA DECAY OF DEFORMED NUCLEI. Fujita, Jun-ichi (Indiana Univ., Bloomington); Emery, Guy. T.; Futami, Yasuhiko. Phys. Rev., C; 1: 2060-2(Jun 1970).

Considerations based on the projection-operator method indicate the need for modifications of Alaga's asymptotic quantum-number selection rules for allowed beta transitions of deformed nuclei. Certain transitions previously classified as allowed-hindered can be expected to have beta moments only slightly smaller than those of allowed-unhindered transitions. The distribution of log ft values for the $150 \leq A \leq 190$ region seems to show such an effect, and detailed calculations for several cases give results in agreement with the available data. (auth)

40714 PHENOMENOLOGICAL DETERMINATION OF THE IMPORTANCE OF EXCHANGE CURRENTS IN NUCLEI. Bosco, B. (Johns Hopkins Univ., Baltimore. Stanford Univ., Calif.); Piazza, A. Contract NONR 225(67). Phys. Rev., C; 1: 787-95(Mar 1970).

The comparison between the magnetic dipole cross sections obtained from photon and electron disintegration experiments is shown to be a meaningful test for the determination of the im-

portance of the exchange currents in nuclei. The proof is obtained by explicit use of the Foldy–Osborn invariants. A detailed discussion is given of the kinematical situation in which the test should be applied. (auth)

40715 UNIFIED REACTION FORMULATION WITH TWO PARTICLES IN THE CONTINUUM. Kazaks, P. A.; Koshel, R. D. (Ohio Univ., Athens). Phys. Rev., C; 1: 1906-9(Jun 1970).

By means of a Faddeev-like method, a formulation of nuclear reactions leading to three-fragment final channels is presented. It is a shell-model theory of nuclear reactions in which two particles in the continuum in the intermediate states can be dealt with in principle. The amplitude also includes as one term the distorted-wave t-matrix approximation (DWTA). An approximate treatment of the resonance-type term leads to a two-step process for (p,2p) reactions. The importance of such a mechanism, which proceeds via the 1p-1h or 2p-2h states of the target nucleus, is presented for reactions which heretofore have been analyzed by means of the DWTA. (auth)

40716 CLUSTER-MODEL VERTEX FUNCTIONS FOR ^{16}O: MONOPOLE FORM FACTORS. Noble, J. V. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C; 1: 1900-5(Jun 1970).

A simple phenomenological model of the vertex functions (virtual decay amplitudes) describing the reactions $^{16}O(g.s) \rightarrow \alpha + {}^{12}C$, and $^{16}O(6.056\ MeV) \rightarrow \alpha + {}^{12}C$ is introduced. These vertex functions (under certain assumptions) can be used to predict the elastic and inelastic electron scattering monopole form factors, as well as describing hadronic reactions such as α-cluster transfer and excitation. The monopole form factors are compared with recent data: The ratio of the inelastic form factor to experiment is about 4 (as compared with deformed and spherical shell-model predictions which give $<\frac{1}{2}$ for this ratio), owing to the excessive collectiveness of this description of the transition. (auth)

40717 NUCLEAR GROUND-STATE CORRELATIONS AND BOSON EXPANSIONS. Da Providencia, J. (Univ., Coimbra, Portugal. Comissao de Estudos de Energia Nuclear, Lisbon); Weneser, J. Phys. Rev., C; 1: 825-33(Mar 1970).

It is well known that the second-order ground-state correlation energy calculated in the usual random-phase approximation (RPA) is off by a factor of 2. It is also noted that there is a factor-of-2 discrepancy in the correlation corrections to the Hartree–Fock occupation probabilities. The reason for these phenomena is traced to the treatment of the exchange terms in the interaction matrix element. An illustration based on a simple single multipole interaction shows that the factor of 2 arises from a coherent sum of small higher-order terms. Results based on the consideration of one or a few eigenmodes at a time are seen to be free of this difficulty. The correlation energy, occupation-probability corrections, and equations of motion are reexamined in the Beliaev–Zelevinsky boson expansion, as an illustration of clearly defined higher-order treatments. (auth)

40718 EFFECT OF THE KNOCKOUT-EXCHANGE MECHANISM IN NUCLEON–NUCLEUS SCATTERING. Atkinson, Jay (Univ. of California, Livermore); Madsen, V. A. Phys. Rev., C; 1: 1377-1400(Apr 1970).

The contribution of the knockout-exchange mechanism to inelastic proton scattering in the distorted-wave Born approximation (DWBA) is studied as a function of two-body force range, orbital-angular-momentum transfer, incident-particle energy, and bound-particle energy and configuration. Several important features are revealed: (1) The exchange mechanism is found to be important for reasonalbe ranges (≈ 1 F) and for energies as high as 150 MeV; (2) the exchange-to-direct ratio is quite sensitive to the orbital-angular-momentum transfer L, and the exchange amplitude can exceed the direct for large L; (3) nonnormal transfers $[(-1)^{L}\neq(-1)^{\Delta T}]$ are usually negligible but may become significant for high L, especially if no spin flip is involved; (4) both the magnitude and phase of the exchange amplitude relative to the direct are sensitive to the initial and final single-particle configurations, particularly to the radial quantum numbers; (5) in collective excitations constructive interference occurs among exchange amplitudes to a sufficient extent that the inclusion of exchange can double the cross section for 2^+ states. Expressions for direct and exchange amplitudes are obtained in the zero-range limit of the PWBA which qualitatively explain the behavior observed in the numerical results. A new method is presented for estimating collective enhancement due to core polarization by using empirical B(E2) values. Calculation of the absolute cross section for the 2^+ excitation in $^{116}Sn(p,p')$, including exchange and core polarization, yields a two-body effective interaction strength which agrees both with strengths derived from charge-exchange reactions and with those obtained from a semirealistic two-nucleon interaction. (auth)

40719 COMPLETE SEMIREALISTIC EFFECTIVE INTERACTIONS FOR THE NUCLEAR SHELL MODEL. Saunier, Gerard; Pearson, J. M. (Univ., Montreal). Phys. Rev., C; 1: 1353-64(Apr 1970).

Since there exists considerable uncertainty in the short-range part of the real nucleon–nucleon interaction, any attempt at a rigorous derivation of the effective interaction is illusory. Rather, requiring the effective interaction to conform to the real interaction in the long-range part is the furthest that one can meaningfully go in relating the two, and that the short-range part of the effective interaction should be chosen phenomenologically. Earlier work is here extended to impose phenomenological constraints on the vector (spin-orbit) and tensor components of the effective interaction. The short-range phenomenological part of the effective interaction is to be chosen in such a way that the entire interaction satisfies the following conditions: (a) Nuclear matter is correctly saturated in first-order perturbation theory, with small second-order corrections. (b) The odd-state scattering parameters are fitted up to 300 MeV. (c) The low-energy singlet scattering parameters are fitted. (d) The low-energy triplet scattering parameters and the quadrupole moment of the deuteron are fitted. It is never possible to satisfy more than three conditions simultaneously, and so arrive at four effective interactions, each of which is characterized by the violation of one of the above conditions. Two of these interactions are found to work well for both Hartree–Fock and spectroscopic calculations, and, hence, may be regarded as having some measure of universality. (auth)

40720 ELASTIC FORM FACTOR OF ^{16}O. McDonald, L. J. (Catholic Univ. of America, Washington, D. C.); Ueberall, H. Phys. Rev., C; 1: 2156-7(Jun 1970).

The recently discovered second diffraction minimum in the elastic form factor of ^{16}O, alternatively described by a harmonic-oscillator model containing pair correlations or by an independent-particle model with a finite Woods–Saxon well, can also be obtained by the much simpler α-particle model. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 39177, 39181, 39187, 39199, 39270, and 41048.

40721 (FN-E-79) EVALUATION OF OPERATING LIMITS OF THE CORE OF THE ELECTRONUCLEAR PLANT OF TRINO VERCELLESE BASED ON THE RESULTS OBTAINED DURING THE FIRST CYCLE. (FIAT, Turin (Italy). Sezione Energia Nucleare). Apr 1967. 129p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The results of a first evaluation concerning conditions predicted for the second cycle of the core are presented. Results are given on the evaluation of hot channel nuclear factors, hydraulic characteristics of the core, definition of operating limits, data for the thermohydraulic analysis of the core, and safety verification of the core. (J.S.R.)

40722 (TRG-Report-1911, pp 175-83) FUEL ELEMENT IRRADIATION IN THE KNK FOR THE DEVELOPMENT OF THE GERMAN FAST BREEDER. Plessa, A. G. (Siemens-Interatom Consortium, Erlangen (West Germany)).

After a period of operation with a thermal core, the compact sodium-cooled KNK reactor at Karlsruhe will have a fast core, KNKII, built to serve as a test bed for fuel sub-assemblies for the 300MW sodium-cooled fast breeder prototype, SNR. The extent to which the conditions in SNR can be simulated in KNKII is shown by comparison of the principal data and values of the two reactors. It is concluded that irradiation results from KNKII fuel sub-assemblies will be representative for fuel behavior and clad stresses for SNR. (UK)

40723 DECISION FOR THE PHILIPPSBURG NUCLEAR POWER PLANT. FROM THE VIEWPOINT OF THE OWNERS. Guck, R. (Vorstandmitglied der Badenwerk AG, Karlsruhe, Ger.). Atomwirt., Atomtech.; 15: 318-19(Jul 1970). (In German).

Cost analysis shows that in south West Germany new power stations can be developed only on an oil or nuclear energy basis. Because of transportation problems, coal and gas are too expensive. Uncertainties about oil supply favor nuclear power stations. Factors determining site selection are as follows: favorable location with respect to consumer centers, connection into the existing grid system, sufficient cooling water, good transportation system, and sufficient area for later expansion to a total power of 2000 to 3000 MW(e). Based on these factors, Philippsburg on the Rhine River was selected for the site. Construction of the first block, a boiling water reactor with 864 MW(e), is planned for the fall of 1970 and will be finished by the end of 1974. (H.B.G.)

40724 900-MW PHILIPPSBURG NUCLEAR POWER PLANT WITH AEG BOILING-WATER REACTOR. Huettl, A. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main); Moll, W. Atomwirt., Atomtech.; 15: 320-3(Jul 1970). (In German).

The nuclear power plant at Philippsburg with about 900 MW(e) will be the largest boiling water reactor in Europe. Most components of the plant will be largely standardized and proven. For all practical purposes, the Philippsburg plant is an enlargement of the Brunsbuettel power station. The diameter of the containment vessel, in spite of the higher power, will not exceed that of Brunsbuettel. Characteristics of the reactor as to core, fuel elements, cooling system, control system, containment vessel, turbine condenser, and generator are tabulated. Floor plan, cross section, and architectural design are depicted. (H.B.G.)

40725 SHIELDING TESTS AT SAINT-LAURENT I. Rafalovitch, A. Bull. Dir. Etud. Rech., Ser. A; No. 4, 35-74(1969). (In French).

Recent developments in gamma and neutron flux measurement techniques when starting graphite/gas type reactors are described. Preparation and organization are emphasized according to the particular conditions during tests at the actual plant. Measurement accuracy is also discussed. (auth)

40726 NUCLEAR ENERGY IN 1969. Negrini, R. Energ. Nucl. (Milan); 17: 422-8(Jul 1970). (In Italian).

A synthetic review is given of the 1969 main events and activities relevant to nuclear energy and its use for power generation. Fuel cycle developments are described. (auth)

40727 REACTOR CORE MEASUREMENTS AT CONNECTICUT YANKEE AND ZORITA. Loving, J. J.; Nath, R. J. (Westinghouse Nuclear Energy Systems, Pittsburgh). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 555-63(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

In-core power distribution measurements are made in the Connecticut-Yankee and Zorita reactor cores by means of movable miniature fission chambers and in-core thermocouples. The movable miniature fission chambers traverse the entire active length of selected fuel assemblies to provide a three-dimensional measure of the relative power distribution within the reactor core. In addition, chromel-alumel thermocouples are located above preselected fuel assemblies to measure the outlet temperature which is proportional to the integrated relative fuel assembly power sharing. (4 references.) (auth)

40728 DIRECT DIGITAL CONTROL OF A NUCLEAR POWER REACTOR. Luopa, J. A.; Anderton, R. D. (Canadian General Electric, Ontario). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 586-93(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Duplicated digital computers will directly manipulate the reactivity devices of the KANUPP 137 MW(e) HWR to match the reactor power output to the turbine demand. The system design and testing programs, with emphasis on the methods of signal conditioning, the choice of sampling and control calculation frequencies, and the transformation of analog control algorithms to recursive form, are described. (7 references.) (auth)

Operation and Economics

40729 (DLCS-5000170) SHIPPINGPORT ATOMIC POWER STATION. Quarterly Operating Report, First Quarter 1970. (Duquesne Light Co., Shippingport, Pa. Power Stations Dept.). Contract AT(11-1)-292. 16p. Dep. CFSTI.

40730 (DOCKET-1153-9) HALLAM NUCLEAR POWER FACILITY. Monthly Operating Report, No. 42, January 1966. (Consumers Public Power District, Hallam, Nebr.). Contract AT(11-1)-513. 16p. (TID-22791). Dep. CFSTI.

40731 (DOCKET-1153-10) HALLAM NUCLEAR POWER FACILITY. Monthly Operating Report, No. 43, February 1966. (Consumers Public Power District, Hallam, Nebr.). Contract AT(11-1)-513. 7p. (TID-22792). Dep. CFSTI.

40732 (DOCKET-1153-11) HALLAM NUCLEAR POWER FACILITY. Monthly Operating Report, No. 44, March 1966. (Consumers Public Power District, Hallam, Nebr.). Contract AT(11-1)-513. 14p. (TID-23022). Dep. CFSTI.

40733 (DOCKET-1153-12) HALLAM NUCLEAR POWER FACILITY. Monthly Operating Report, No. 45, April 1966. (Consumers Public Power District, Hallam, Nebr.). Contract AT(11-1)-513. 15p. (TID-23023). Dep. CFSTI.

40734 (DOCKET-1153-13) HALLAM NUCLEAR POWER FACILITY. Monthly Operating Report, No. 46, May 1966. (Consumers Public Power District, Hallam, Nebr.). Contract AT(11-1)-513. 12p. (TID-23259). Dep. CFSTI.

40735 (DOCKET-1153-14) HALLAM NUCLEAR POWER FACILITY. Monthly Operating Report, No. 47, June 1966. (Consumers Public Power District, Hallam, Nebr.). Contract AT(11-1)-513. 15p. (TID-23306). Dep. CFSTI.

40736 (DOCKET-1153-15) HALLAM NUCLEAR POWER FACILITY. Monthly Operating Report, No. 48, July 1966. (Consumers Public Power District, Hallam, Nebr.). Contract AT(11-1)-513. 8p. (TID-23346). Dep. CFSTI.

40737 (DOCKET-1155-60) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report, March 1970. (Dairyland Power Cooperative, La Crosse, Wis.). 28 Jul 1970. Contract AT(11-1)-851. 22p. Dep. CFSTI.

40738 (DOCKET-50016-44) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, October 1968. (Power Reactor Development Co., Detroit, Mich.). 12p. (PRDC-EF-62). Dep. CFSTI.

40739 (DOCKET-50016-45) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, January 1969. (Power Reactor Development Co., Detroit, Mich.). 7p. (PRDC-EF-65). Dep. CFSTI.

40740 (DOCKET-50016-46) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, February 1969. (Power Reactor Development Co., Detroit, Mich.). 7p. (PRDC-EF-66). Dep. CFSTI.

40741 (DOCKET-50016-47) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, March 1968. (Power Reactor Development Co., Detroit, Mich.). 7p. (PRDC-EF-55). Dep. CFSTI.

40742 (DOCKET-50016-48) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, February 1968. (Power Reactor Development Co., Detroit, Mich.). 6p. (PRDC-EF-54). Dep. CFSTI.

40743 (DOCKET-50016-49) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, October 1966. (Power Reactor Development Co., Detroit, Mich.). 19p. (PRDC-EF-38). Dep. CFSTI.

40744 (DOCKET-50016-50) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, September 1966. (Power Reactor Development Co., Detroit, Mich.). 10p. (PRDC-EF-37). Dep. CFSTI.

40745 (DOCKET-50016-51) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, August 1966. (Power Reactor Development Co., Detroit, Mich.). 11p. (PRDC-EF-36). Dep. CFSTI.

40746 (DOCKET-50016-52) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, December 1967. (Power Reactor Development Co., Detroit, Mich.). 8p. (PRDC-EF-52). Dep. CFSTI.

40747 (DOCKET-50016-53) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, December 1968. (Power Reactor Development Co., Detroit, Mich.). 9p. (PRDC-EF-64). Dep. CFSTI.

40748 (DOCKET-50016-54) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, April 1968. (Power Reactor Development Co., Detroit, Mich.). 7p. (PRDC-EF-56). Dep. CFSTI.

40749 (DOCKET-50016-55) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, March 1969. (Power Reactor Development Co., Detroit, Mich.). 11p. (PRDC-EF-67). Dep. CFSTI.

40750 (DOCKET-50016-56) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, July 1968. (Power Reactor Development Co., Detroit, Mich.). 7p. (PRDC-EF-59). Dep. CFSTI.

40751 (DOCKET-50016-57) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, July 1966. (Power Reactor Development Co., Detroit, Mich.). 13p. (PRDC-EF-35). Dep. CFSTI.

40752 (DOCKET-50016-58) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, May 1967. (Power Reactor Development Co., Detroit, Mich.). 9p. (PRDC-EF-45). Dep. CFSTI.

40753 (DOCKET-50016-59) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, June 1967. (Power Reactor Development Co., Detroit, Mich.). 10p. (PRDC-EF-46). Dep. CFSTI.

40754 (DOCKET-50016-60) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, November 1968. (Power Reactor Development Co., Detroit, Mich.). 13p. (PRDC-EF-63). Dep. CFSTI.

40755 (DOCKET-50016-61) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, April 1967. (Power Reactor Development Co., Detroit, Mich.). 10p. (PRDC-EF-44). Dep. CFSTI.

40756 (DOCKET-50016-62) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, March 1967. (Power Reactor Development Co., Detroit, Mich.). 11p. (PRDC-EF-43). Dep. CFSTI.

40757 (DOCKET-50016-63) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, January 1968. (Power Reactor Development Co., Detroit, Mich.). 9p. (PRDC-EF-53). Dep. CFSTI.

40758 (DOCKET-50016-64) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, June 1968. (Power Reactor Development Co., Detroit, Mich.). 8p. (PRDC-EF-58). Dep. CFSTI.

40759 (DOCKET-50016-65) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, May 1968. (Power Reactor Development Co., Detroit, Mich.). 9p. (PRDC-EF-57). Dep. CFSTI.

40760 (DOCKET-50016-66) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, August 1968. (Power Reactor Development Co., Detroit, Mich.). 8p. (PRDC-EF-60). Dep. CFSTI.

40761 (DOCKET-50016-67) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, September 1968. (Power Reactor Development Co., Detroit, Mich.). 7p. (PRDC-EF-61). Dep. CFSTI.

40762 (DOCKET-50016-68) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, September 1967. (Power Reactor Development Co., Detroit, Mich.). 7p. (PRDC-EF-49). Dep. CFSTI.

40763 (DOCKET-50016-69) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, February 1967. (Power Reactor Development Co., Detroit, Mich.). 10p. (PRDC-EF-42). Dep. CFSTI.

40764 (DOCKET-50016-70) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, January 1967. (Power Reactor Development Co., Detroit, Mich.). 12p. (PRDC-EF-41). Dep. CFSTI.

40765 (DOCKET-50016-71) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, December 1966. (Power Reactor Development Co., Detroit, Mich.). 12p. (PRDC-EF-40). Dep. CFSTI.

40766 (DOCKET-50016-72) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, July 1967. (Power Reactor Development Co., Detroit, Mich.). 10p. (PRDC-EF-47). Dep. CFSTI.

40767 (DOCKET-50016-73) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, November 1966. (Power Reactor Development Co., Detroit, Mich.). 9p. (PRDC-EF-39). Dep. CFSTI.

40768 (DOCKET-50029-124) YANKEE NUCLEAR POWER STATION. Operation Report No. 114, June 1970. (Yankee Atomic Electric Co., Westboro, Mass.). 22 Jul 1970. 7p. Dep. CFSTI.

40769 (DOCKET-50206-56) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, June 1970. (Southern California Edison Co., Los Angeles). Jul 1970. Contract AT(30-1)-3270. 5p. (NYO-3270-39). Dep. CFSTI.

40770 (DOCKET-50213-48) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 67-9, September 1967. (Connecticut Yankee Atomic Power Co., Haddam). 25 Oct 1967. Contract AT(30-1)-3250. 8p. (NYO-3250-14). Dep. CFSTI.

40771 (DOCKET-50213-49) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 67-7, July 1967. (Connecticut Yankee Atomic Power Co., Haddam). 18 Aug 1967. Contract AT(30-1)-3250. 15p. (NYO-3250-12). Dep. CFSTI.

40772 (DOCKET-50213-50) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 68-10, October 1968. (Connecticut Yankee Atomic Power Co., Haddam). 19 Nov 1968. Contract AT(30-1)-3250. 7p. (NYO-3250-28). Dep. CFSTI.

40773 (DOCKET-50213-51) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 68-9, September 1968. (Connecticut Yankee Atomic Power Co., Haddam). 10 Oct 1968. Contract AT(30-1)-3250. 9p. (NYO-3250-26). Dep. CFSTI.

40774 (DOCKET-50213-52) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 68-8, August 1968. (Connecticut Yankee Atomic Power Co., Haddam). 12 Sep 1968. Contract AT(30-1)-3250. 12p. (NYO-3250-25). Dep. CFSTI.

40775 (DOCKET-50213-53) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 68-4, April 1968. (Connecticut Yankee Atomic Power Co., Haddam). 14 May 1968. Contract AT(30-1)-3250. 10p. (NYO-3250-21). Dep. CFSTI.

40776 (DOCKET-50213-54) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 68-6, June 1968. (Connecticut Yankee Atomic Power Co., Haddam). 12 Jul 1968. Contract AT(30-1)-3250. 11p. (NYO-3250-23). Dep. CFSTI.

40777 (DOCKET-50213-55) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 68-5, May 1968. (Connecticut Yankee Atomic Power Co., Haddam). 12 Jun 1968. Contract AT(30-1)-3250. 8p. (NYO-3250-22). Dep. CFSTI.

40778 (DOCKET-50213-56) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 68-3, March 1968. (Connecticut Yankee Atomic Power Co., Haddam). 11 Apr 1968. Contract AT(30-1)-3250. 12p. (NYO-3250-20). Dep. CFSTI.

40779 (DOCKET-50213-57) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 68-2, February 1968. (Connecticut Yankee Atomic Power Co., Haddam). 12 Mar 1968. Contract AT(30-1)-3250. 10p. (NYO-3250-19). Dep. CFSTI.

40780 (DOCKET-50213-58) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 69-2, February 1969. (Connecticut Yankee Atomic Power Co., Haddam). 13 Mar 1969. Contract AT(30-1)-3250. 17p. (NYO-3250-32). Dep. CFSTI.

40781 (DOCKET-50213-59) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 68-12, December 1968. (Connecticut Yankee Atomic Power Co., Haddam). 14 Jan 1969. Contract AT(30-1)-3250. 22p. (NYO-3250-30). $_{24}$Dep. CFSTI.

40782 (DOCKET-50213-60) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 68-1, January 1968. (Connecticut Yankee Atomic Power Co., Haddam). 9 Feb 1968. Contract AT(30-1)-3250. 11p. (NYO-3250-18). Dep. CFSTI.

40783 (DOCKET-50213-61) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 67-11, November 1967. (Connecticut Yankee Atomic Power Co., Haddam). 19 Dec 1967. Contract AT(30-1)-3250. 16p. (NYO-3250-16). Dep. CFSTI.

40784 (DOCKET-50213-62) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 69-5, May 1969. (Connecticut Yankee Atomic Power Co., Haddam). 19 Jun 1969. Contract AT(30-1)-3250. 16p. (NYO-3250-35). Dep. CFSTI.

40785 (DOCKET-50213-63) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 69-4, April 1969. (Connecticut Yankee Atomic Power Co., Haddam). 16 May 1969. Contract AT(30-1)-3250. 22p. (NYO-3250-34). Dep. CFSTI.

40786 (DOCKET-50213-64) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 67-8, August 1967. (Connecticut Yankee Atomic Power Co., Haddam). 18 Sep 1967. Contract AT(30-1)-3250. 14p. (NYO-3250-13). Dep. CFSTI.

40787 (DOCKET-50213-65) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 67-10, October 1967. (Connecticut Yankee Atomic Power Co., Haddam). 17 Nov 1967. Contract AT(30-1)-3250. 14p. (NYO-3250-15). Dep. CFSTI.

40788 (DOCKET-50213-66) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 68-11, November 1968. (Connecticut Yankee Atomic Power Co., Haddam). 20 Dec 1968. Contract AT(30-1)-3250. 20p. (NYO-3250-29). Dep. CFSTI.

40789 (DOCKET-50213-67) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 69-1, January 1969. (Connecticut Yankee Atomic Power Co., Haddam). 11 Feb 1969. Contract AT(30-1)-3250. 16p. (NYO-3250-31). Dep. CFSTI.

40790 (DOCKET-50213-68) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 69-3, March 1969. (Connecticut Yankee Atomic Power Co., Haddam). 18 Apr 1969. Contract AT(30-1)-3250. 17p. (NYO-3250-33). Dep. CFSTI.

40791 (DOCKET-50213-69) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 67-12, December 1967. (Connecticut Yankee Atomic Power Co., Haddam). 15 Jan 1968. Contract AT(30-1)-3250. 14p. (NYO-3250-17). Dep. CFSTI.

40792 (DOCKET-50213-70) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 70-6, June 1970. (Connecticut Yankee Atomic Power Co., Haddam). 27 Jul 1970. Contract AT(30-1)-3250. 18p. (NYO-3250-49). Dep. CFSTI.

40793 SIMULATOR TRAINING OF OPERATING PERSONNEL FOR NUCLEAR POWER PLANTS. DEVELOPMENT AND METHODS IN THE USA. Jaerschky, R.; Martin, H.-D. (Kraftwerk Union AG, Frankfurt am Main). Atomwirt., Atomtech.; 15: 329-30(Jul 1970). (In German).

Based on experiences during a 12 week course on reactor simulators in the USA, it was concluded that sudden incidents triggered either erroneous or delayed counter measures by personnel. In an actual power plant, such human failures would cause shutdowns and costly power losses. Therefore, a simulator training center was proposed for Germany, not only to conduct courses for new personnel but also to perform refresher courses for experienced technicians. (H.B.G.)

Safety and Siting

40794 (DOCKET-1153-16) HALLAM NUCLEAR POWER FACILITY. Environmental Monitoring Program. Quarterly Report No. 24, April-June 1967. (Controls for Radiation, Inc., Cambridge, Mass.). 12p. (TID-25118). Dep. CFSTI.

For Consumers Public Power District, Hallam, Nebr.

40795 (DOCKET-1155-40) LA CROSSE BOILING WATER REACTOR. Power Test Program. Final Report. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Jul 1970. 383p. (ACNP-70501). Dep. CFSTI.

40796 (DOCKET-1155-56) LA CROSSE BOILING WATER REACTOR. Incident Reports No. DPC-70-4, 5, 6, 7, 8, and 9. (Dairyland Power Cooperative, La Crosse, Wis.). 21 Jul 1970. 14p. Dep. CFSTI.

40797 (DOCKET-1155-58) LA CROSSE BOILING-WATER REACTOR. Safeguards Report for Operating Authorization, Volume I. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Revised Aug 1967. Contract AT(11-1)-850. 409p. (ACNP-65544(Vol.1)). Dep. CFSTI.

Information on the La Crosse Boiling-Water Reactor is presented under the following broad topics: site; reactor, systems descriptions; containment building; and power plant. (D.C.C.)

40798 (DOCKET-1155-59) LA CROSSE BOILING-WATER REACTOR. Safeguards Report for Operating Authorization, Volume II. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Revised Aug 1967. Contract AT(11-1)-850. 425p. (ACNP-65544(Vol.2)). Dep. CFSTI.

Information on the La Crosse Boiling-Water Reactor is presented under the following broad topics: instrumentation and control; electrical distribution; shielding; operating principles and safeguards; environmental survey; administrative and operational procedures; safeguards evaluation; and evacuation procedures. (D.C.C.)

40799 (DOCKET-50003-46) INDIAN POINT STATION, UNIT NO. 1. Authorization for Temporary Measures. (Division of Reactor Licensing (AEC), Washington, D. C.). 24 Jul 1970. 1p. Dep. CFSTI.

40800 (DOCKET-50016-43) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. License No. DPR-9. Request for Technical Specifications Change No. 23. (Power Reactor Development Co., Detroit, Mich.). 20 Jul 1970. 11p. Dep. CFSTI.

Raised power limits for Core A fuel elements which were located in the high pressure plenum and were operated at a power level above 1 MW(t) on or before October 5, 1966 are presented. (D.C.C.)

40801 (DOCKET-50016-74) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Correction to Request of Technical Specifications Change No. 23. (Power Reactor Development Co., Detroit, Mich.). 30 Jul 1970. 5p. Dep. CFSTI.

A correction to the technical specification change relating to possible fuel melting and clad cracking conditions is presented. (D.C.C.)

40802 (DOCKET-50029-121) YANKEE NUCLEAR POWER STATION. License Application, Proposed Change No. 95. (Yankee Atomic Electric Co., Westboro, Mass.). 15 Jul 1970. 3p. Dep. CFSTI.

An additional water circulation system is described for returning water from the containment sump to the cooling system. (D.C.C.)

40803 (DOCKET-50029-123) YANKEE NUCLEAR POWER STATION. Request for Authorization of Proposed Change No. 93 to Fuel Handling System. (Yankee Atomic Electric Co., Westboro, Mass.). 24 Jul 1970. 5p. Dep. CFSTI.

The use of a lead and steel transfer cask for transporting irradiated fuel elements and components from the reactor to the spent fuel pit is described. (D.C.C.)

40804 (DOCKET-50029-125) YANKEE NUCLEAR POWER STATION. License No. DPR-3; Technical Specifications Proposed Change No. 95, Suppl. 1. (Yankee Atomic Electric Co., Westboro, Mass.). 22 Jul 1970. 3p. Dep. CFSTI.

Information concerning the relocation of two 2.5 inch motor operated valves in the emergency core cooling system flow circuit is presented. (D.C.C.)

40805 (DOCKET-50133-34) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Tests to be Performed Prior to Resumption of Power Operation. (Division of Reactor Licensing (AEC), Washington, D. C.). 23 Jul 1970. 4p. Dep. CFSTI.
For Pacific Gas and Electric Co., San Francisco, Calif.

40806 (DOCKET-50133-35) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Conditions for Resumption of Power. (Division of Reactor Licensing (AEC), Washington, D. C.). 28 Jul 1970. 4p. Dep. CFSTI.

40807 (DOCKET-50206-79) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operating History and Verification of Design Objectives, Part I, Volume I. (Southern California Edison Co., Camp Pendleton, Calif. San Diego Gas and Electric Co., Calif.). 13 Aug 1970. 340p. Dep. CFSTI.

40808 (DOCKET-50206-80) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Final Safety Analysis, Part II, Volume II. (Southern California Edison Co., Camp Pendleton, Calif. San Diego Gas and Electric Co., Calif.). 13 Aug 1970. 294p. Dep. CFSTI.

Information on San Onofre Power Reactor Unit 1 is presented under the following broad topics: site description; and plant facilities and reactor cycle. (D.C.C.)

40809 (DOCKET-50206-81) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Final Safety Analysis, Part II, Volume III. (Southern California Edison Co., Camp Pendleton, Calif. San Diego Gas and Electric Co., Calif.). 13 Aug 1970. 474p. Dep. CFSTI.

Information on the San Onofre Power Reactor Unit 1 is presented under the following broad topics: reactor cycle; turbine cycle; and engineered safeguards. (D.C.C.)

40810 (DOCKET-50206-82) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Final Safety Analysis, Part II, Volume IV. (Southern California Edison Co., Camp Pendleton, Calif. San Diego Gas and Electric Co., Calif.). 13 Aug 1970. 333p. Dep. CFSTI.

Information on the San Onofre Power Reactor Unit 1 is presented under the following broad topics: containment sphere; instrumentation and control systems; administration; and reactivity fault analyses. (D.C.C.)

40811 (DOCKET-50206-83) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Final Safety Analysis, Part II, Volume V. (Southern California Edison Co., Camp Pendleton, Calif. San Diego Gas and Electric Co., Calif.). 13 Aug 1970. 298p. Dep. CFSTI.

Information on San Onofre Power Reactor Unit 1 is presented under the following broad topics: mechanical malfunction analyses; plant behavior; chemical reactions; fission product inventory; hypothetical accident; and environmental consequences. (D.C.C.)

40812 (DOCKET-50219-80) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Isolation Condenser Trip Reset. (Jersey Central Power and Light Co., Morristown, N. J.). 2 Jul 1970. 2p. Dep. CFSTI.

A revised trip setting for high flow in the isolation condenser is presented. Conditions for manual actuation of the isolation condenser system are described. (D.C.C.)

40813 (DOCKET-50219-81) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Hazards Analysis. (Division of Reactor Licensing (AEC), Washington, D. C.). 23 Sep 1964. 64p. Dep. CFSTI.

40814 (DOCKET-50219-82) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Facility Description and Safety Analysis Report, Amendment 3. (Division of Reactor Licensing (AEC), Washington, D. C.). 21 Jun 1967. 21p. Dep. CFSTI.

Requests for additional information concerning safety aspects of reactor systems and the reactor site are presented. (D.C.C.)

40815 (DOCKET-50219-83) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Request for Additional Information. (Division of Reactor Licensing (AEC), Washington, D. C.). 16 Oct 1967. 10p. Dep. CFSTI.

40816 (DOCKET-50219-84) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Request for Additional Information. (Division of Reactor Licensing (AEC), Washington, D. C.). 7 Nov 1967. 2p. Dep. CFSTI.

40817 (DOCKET-50219-85) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Actions to be Completed Before Issuance of a Provisional Operating License and Actions Which May be Submitted in Design. (Division of Reactor Licensing (AEC), Washington, D. C.). 20 Nov 1967. 4p. Dep. CFSTI.

40818 (DOCKET-50219-86) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Items to be Resolved Before Issuance of a Provisional Operating License. (Division of Reactor Licensing (AEC), Washington, D. C.). 9 Jan 1968. 7p. Dep. CFSTI.

40819 (DOCKET-50219-87) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Responsibilities of Subcontractors for Various Quality Control Programs. (Division of Reactor Licensing (AEC), Washington, D. C.). 16 Feb 1968. 2p. Dep. CFSTI.

40820 (DOCKET-50219-88) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Request for Information on Repair Program of Defective Field Welds. (Division of Reactor Licensing (AEC), Washington, D. C.). 22 Mar 1968. 3p. Dep. CFSTI.

40821 (DOCKET-50219-89) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Request for a Complete Technical Justification for Weld Defects Repair. (Division of Reactor Licensing (AEC), Washington, D. C.). 15 Apr 1968. 1p. Dep. CFSTI.

40822 (DOCKET-50219-90) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Request for Dye Penetrant Test on Two Stub Tube Welds. (Division of Reactor Licensing (AEC), Washington, D. C.). 25 Jun 1968. 2p. Dep. CFSTI.

40823 (DOCKET-50219-91) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. ACRS Report. (Atomic Energy Commission, Washington, D. C. Advisory Committee on Reactor Safeguards). 20 Dec 1968. 12p. Dep. CFSTI.

40824 (DOCKET-50219-93) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Request and Grant of Waiver of Section 3.4.C of Technical Specifications for Demonstration. (Jersey Central Power and Light Co., Morristown, N. J.). 11 Nov 1969. 5p. Dep. CFSTI.

40825 (DOCKET-50219-94) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Provisional Operating License Change Request No. 1 with Supplement No. 1. (Jersey Central Power and Light Co., Morristown, N. J.). 11 Nov 1969. 8p. Dep. CFSTI.

Changes in safety limits for fuel cladding integrity are described. (D.C.C.)

40826 (DOCKET-50219-97) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Provisional Operating License. (Division of Reactor Licensing (AEC), Washington, D. C.). 9 Apr 1969. 5p. Dep. CFSTI.

40827 (DOCKET-50219-98) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Addendum to the Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 9 Apr 1969. 1p. Dep. CFSTI.

Additional information on design requirements of containment structure penetrations is presented. (D.C.C.)

40828 (DOCKET-50220-47) NINE MILE POINT NUCLEAR STATION. Results of Valve Tests. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 22 Jul 1970. 1p. Dep. CFSTI.

40829 (DOCKET-50237-59) DRESDEN NUCLEAR POWER STATION, UNIT 2. Excessive Closure Time for Valves 203-2B and 203-2C. (Commonwealth Edison Co., Chicago, Ill.). 23 Jul 1970. 2p. Dep. CFSTI.

40830 (DOCKET-50237-60) DRESDEN NUCLEAR POWER STATION, UNIT 2. Excessive Closure Time for Main Steam Isolation Valves. (Commonwealth Edison Co., Chicago, Ill.). 23 Jul 1970. 2p. Dep. CFSTI.

40831 (DOCKET-50237-61) DRESDEN NUCLEAR POWER STATION, UNIT 2. Proposed Change No. 4 to Appendix A of DPR-19. (Commonwealth Edison Co., Chicago, Ill.). 29 Jul 1970. 3p. Dep. CFSTI.

Modifications to technical specifications concerning containment system requirements are presented. (D.C.C.)

40832 (DOCKET-50237-62) DRESDEN NUCLEAR POWER STATION, UNIT 2. Supplementary Information to Special Report of Incident of June 5, 1970. (Commonwealth Edison Co., Chicago, Ill.). 27 Jul 1970. 38p. Dep. CFSTI.

40833 (DOCKET-50237-63) DRESDEN NUCLEAR POWER STATION, UNIT 2. Unexplained Fuel Failures and Excessive Control Rod Scram Times. (Commonwealth Edison Co., Chicago, Ill.). 31 Jul 1970. 10p. Dep. CFSTI.

40834 (DOCKET-50237-64) DRESDEN NUCLEAR POWER STATION, UNIT 2. Proposed Change No. 3 to Appendix A of DPR-19, Supplement No. 1. (Commonwealth Edison Co., Chicago, Ill.). 4 Aug 1970. 2p. Dep. CFSTI.

Revised technical specifications concerning the trip level on the high flow isolation condenser line are presented. (D.C.C.)

40835 (DOCKET-50237-65) DRESDEN NUCLEAR POWER STATION, UNIT 2. Proposed Change No. 4 to Appendix A of DPR-19, Supplement No. 1. (Commonwealth Edison Co., Chicago, Ill.). 5 Aug 1970. 5p. Dep. CFSTI.

Revised technical specifications concerning the venting of the primary containment structure are presented. (D.C.C.)

40836 (DOCKET-50244-45) ROBERT GINNA STATION, UNIT NO. 1. Violation of Technical Specification, Sec. 3.1.1.1a, July 6, 1970. (Rochester Gas and Electric Corp., N. Y.). 15 Jul 1970. 3p. Dep. CFSTI.

A violation of technical specifications during a maintenance shutdown which required the stopping of both reactor coolant pumps is described. (D.C.C.)

40837 (DOCKET-50244-46) ROBERT GINNA STATION, UNIT NO. 1. MSIV-1B Valve Not Operating. (Rochester Gas and Electric Corp., N. Y.). 18 May 1970. 1p. Dep. CFSTI.

40838 (DOCKET-50245-37) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 27. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). 31 Jul 1970. 44p. Dep. CFSTI.

The performance of fuel elements with crud inserts is analyzed. Seismic stress limits for Class 1 instrumentation are listed. The fire protection system is described. The startup test program is reviewed. (D.C.C.)

40839 (DOCKET-50247-37) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Preliminary Safety Analysis Report, Amendment 20 (Includes Final Facility Description and Safety Analysis Report, Suppl. 11. (Consolidated Edison Co. of New York, Inc., New York). 17 Jul 1970. 167p. Dep. CFSTI.

Proposed technical specifications for plant operation are presented. Surveillance requirements for the reactor are described. Basic design features of the site, core, cooling system, containment system, and fuel storage facilities are included. Required administrative controls are reviewed. (D.C.C.)

40840 (DOCKET-50247-38) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Preliminary Safety Analysis Report, Amendment 22 (Includes Final Facility Description and Safety Analysis Report, Suppl. 12. (Consolidated Edison Co. of New York, Inc., New York). 29 Jul 1970. 288p. Dep. CFSTI.

Revised and additional information concerning reactor systems is presented. Inspection requirements are described. Personnel qualifications and responsibilities are reviewed. (D.C.C.)

40841 (DOCKET-50249-37) DRESDEN NUCLEAR POWER STATION, UNIT 3. Request for Additional Information Required for Licensing. (Division of Reactor Licensing (AEC), Washington, D. C.). 24 Jul 1970. 7p. Dep. CFSTI.

40842 (DOCKET-50249-38) DRESDEN NUCLEAR POWER STATION, UNIT 3. Environmental Statement. (Commonwealth Edison Co., Chicago, Ill.). 24 Jul 1970. 56p. Dep. CFSTI.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

40843 (DOCKET-50250-27) TURKEY POINT PLANT, UNITS NO. 3 AND NO. 4. Additional Information Requested on FSAR, Preliminary Safety Analysis Report, [Amendment 21], Suppl. 21. (Florida Power and Light Co.). 17 Jul 1970. 69p. (DOCKET-50251-25). Dep. CFSTI.

40844 (DOCKET-50255-27) PALISADES PLANT. Demineralizer and Release Problem. (Consumers Power Co., Jackson, Mich.). 28 Jul 1970. 3p. Dep. CFSTI.

The performance of one of the deborating demineralizers is analyzed. Required clean-up procedures for the removal of released resins are reviewed. Repair of the demineralizer is described. (D.C.C.)

40845 (DOCKET-50261-38) H. B. ROBINSON UNIT NO. 2. Pre-operational Integrated Leakage Rate and Sensitive Leakage Rate Test of the Reactor Containment Building. (Carolina Power and Light Co., Raleigh, N. C.). 23 Jul 1970. 39p. Dep. CFSTI.

40846 (DOCKET-50261-39) H. B. ROBINSON UNIT NO. 2. Preoperational Integrated Leakage Rate and Sensitive Leakage Date Test of Reactor Containment Building, Addendum I. (Carolina Power and Light Co., Raleigh, N. C.). 28 Jul 1970. 20p. Dep. CFSTI.

40847 (DOCKET-50261-40) H. B. ROBINSON UNIT NO. 2, Facility Operating License No. DPR-23; Technical Specifications, Appendix A. (Division of Reactor Licensing (AEC), Washington, D. C.). 31 Jul 1970. 192p. Dep. CFSTI.

For Carolina Power and Light Co., Raleigh, N. C.

40848 (DOCKET-50263-39) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Environmental Monitoring Program Annual Report, 1969. (Northern States Power Co., Minneapolis, Minn.). 1 Jun 1970. 262p. Dep. CFSTI.

40849 (DOCKET-50263-40) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Comments on ACRS Letter of June 15, 1970. (Northern States Power Co., Minneapolis, Minn.). 30 Jul 1970. 5p. Dep. CFSTI.

40850 (DOCKET-50263-41) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Safety System Relay Failures. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 29 Jul 1970. 3p. Dep. CFSTI.

40851 (DOCKET-50266-26) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 10. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). 3 Aug 1970. 122p. (DOCKET-50301-22; WCAP-7525). Dep. CFSTI.

40852 (DOCKET-50269-20) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Preliminary Safety Analysis Report, Amendment 16 (Includes Final Safety Analysis Report, Rev. 8). (Duke Power Co., Charlotte, N. C.). 23 Jul 1970. 90p. (DOCKET-50270-20; DOCKET-50287-17). Dep. CFSTI.

Engineered safeguards are described. Radiation monitoring requirements and radiation dose calculation for the site and environment are analyzed. Fuel handling and waste disposal systems are described. (D.C.C.)

40853 (DOCKET-50271-22) VERMONT YANKEE NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 13-I. (Vermont Yankee Nuclear Power Corp., Rutland). 10 Jul 1970. 49p. Dep. CFSTI.

Revised and additional design parameters for reactor systems are presented. (D.C.C.)

40854 (DOCKET-50271-23) VERMONT YANKEE NUCLEAR POWER STATION. Structural Loading Criteria, Appendix C. Preliminary Safety Analysis Report, Amendment 13-II. (Vermont Yankee Nuclear Power Corp., Rutland). 10 Jul 1970. 72p. Dep. CFSTI.

40855 (DOCKET-50271-25) VERMONT YANKEE NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 14. (Vermont Yankee Nuclear Power Corp., Rutland). 29 Jul 1970. 289p. Dep. CFSTI.

Financial data on the owners of the Vermont Yankee Power Reactor are presented in support of the application for construction permit and operating license. The 1969 Annual Reports for the Central Vermont Public Service Corporation, Green Mountain Power Corporation, New England Electric System, the Connecticut Light and Power Company, the Central Maine Power Company, the Public Service Company of New Hampshire, the Hartford Electric Light Company, the Cambridge Electric Light Company, and the Eastern Utilities Associates are included. (D.C.C.)

40856 (DOCKET-50308-2) BOLSA ISLAND NUCLEAR POWER AND DESALTING PLANT, UNIT 2. Notice of Filing of Application for Construction Permit and Facility License. (Division of Reactor Licensing (AEC), Washington, D. C.). 29 Sep 1967. 3p. Dep. CFSTI.

40857 (DOCKET-50313-21) ARKANSAS NUCLEAR ONE. Preliminary Safety Analysis Report, [Amendment 18], Suppl. 18. (Arkansas Power and Light Co., Little Rock). 13 Jul 1970. 13p. Dep. CFSTI.

Stress analysis of the reinforced concrete containment structure ring girder is presented. (D.C.C.)

40858 (DOCKET-50315-23) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Nonviolation of Applicable Water Quality Standards. (American Electric Power Service Corp., New York). 29 Jul 1970. 7p. (DOCKET-50316-23). Dep. CFSTI.

40859 (DOCKET-50324-16) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Additional Information: Pressure Suppression Concept. (Carolina Power and Light Co., Raleigh, N. C.). 31 Jul 1970. 61p. (DOCKET-50325-16). Dep. CFSTI.

40860 (DOCKET-50329-16) MIDLAND PLANT, UNITS 1 AND 2. Environmental Report, Construction Permit Stage. (Consumers Power Co., Jackson, Mich.). 24 Jul 1970. 19p. (DOCKET-50330-16). Dep. CFSTI.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

40861 (DOCKET-50329-17) MIDLAND PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 14. (Consumers Power Co., Jackson, Mich.). 31 Jul 1970. 42p. (DOCKET-50330-17). Dep. CFSTI.

40862 (DOCKET-50338-20) NORTH ANNA POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 10. (Virginia Electric and Power Co., Richmond). 3 Aug 1970. 53p. (DOCKET-50339-19). Dep. CFSTI.

40863 (DOCKET-50361-8) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Applicants' Environmental Report: Construction Permit Stage. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 28 Jul 1970. 95p. (DOCKET-50362-7). Dep. CFSTI.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

40864 (DOCKET-50363-6) FORKED RIVER NUCLEAR GENERATING STATION, UNIT 1. Applicant's Environmental Report; Construction Permit Stage. (Jersey Central Power and Light Co., Morristown, N. J.). 29 Jul 1970. 26p. Dep. CFSTI.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

40865 (DOCKET-50363-7) OYSTER CREEK NUCLEAR STATION, UNIT 1. FORKED RIVER NUCLEAR STATION, UNIT 1. Circulating Water System: Environmental Considerations. (Burns and Roe, Inc., Oradell, N. J.). Jul 1970. 48p. Dep. CFSTI.

For Jersey Central Power and Light Co., Morristown, N. J.

Power Reactor Development

Refer also to abstracts 38804, 39109, 39110, 39131, 39132, 39385, 39386, 39598, and 39623.

40866 (AI-AEC-12957) USER'S MANUAL FOR THE SOURCE TERM PROGRAM (STP-1) FOR COMPUTING THE DISTRIBUTION OF CORROSION AND FISSION PRODUCTS IN LMFBR'S. Zwetzig, G. B. (Atomics International, Canoga Park, Calif.). 15 Jul 1970. Contract AT(04-3)-701. 99p. Dep. CFSTI.

A manual for use of the Source Term Computer Program (STP-1) is presented. This program, written for the IBM 360, calculates the generation and transport of fission products and activated structural materials in a Liquid Metal-Cooled Fast Breeder Reactor (LMFBR) for user-selected cladding failure rates and core corrosion rates. The program also calculates ^{24}Na and ^{22}Na specific activities in the coolant, and radiation levels in the vicinity of the primary loop. A subroutine for plotting selected quantities is also included. The manual describes the equations used in the calculations, and presents the input data and output for a sample problem. 10 references. (auth)

40867 (DP-Report-76) RESEARCH AND DEVELOPMENT ASPECTS OF THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Shepherd, L. R.; Marien, P. J. (Atomic Energy Establishment, Winfrith (England)). Dec 1961. 41p. (CONF-611006-1). Dep. CFSTI.

From Symposium on Power Reactor Experiments, Vienna, Austria.

The purpose of the Project, the problems arising, the Dragon Research and Development program, and the utilization of the Reactor Experiment in the development of high temperature gas cooled reactors are discussed. (auth)

40868 (DP-Report-79) PROGRESS IN THE CHEMISTRY AND CHEMICAL ENGINEERING BRANCH OF THE RESEARCH AND DEVELOPMENT DIVISION. Project DRAGON. De Bruijn, H. (Atomic Energy Establishment, Winfrith (England)). Mar 1962. 36p. Dep. CFSTI.

Progress during 1961 in the areas of carbon mass transfer, coolant processing, and fission product technology is reviewed briefly. (H.D.R.)

40869 (DP-Report-83) CHEMISTRY AND CHEMICAL ENGINEERING APPLIED IN HIGH TEMPERATURE GAS COOLED NUCLEAR POWER REACTORS. Project DRAGON. De Bruijn, H. (Atomic Energy Establishment, Winfrith (England)). Feb 1962. 32p. Dep. CFSTI.

The general design features of a high temperature gas cooled nuclear power reactor are given. Some of the main chemical problems connected with a high temperature gas cooled graphite moderated reactor are mentioned. In particular, attention is given to the corrosion of graphite by the oxidizing impurities of the coolant and to fission product control. Those design details of the Dragon reactor and the General Atomic reactor which are connected with these chemical problems are mentioned briefly. The removal on a technical scale of the impurities introduced in the coolant during reactor operation and of the fission products by delay and trapping is discussed. In particular, attention is given to the use of low temperature adsorption techniques. The main chemical problems are considered from a point of view of further reactor development. The use of BeO as a substitute for graphite in certain vital parts of the reactor is discussed. It is concluded that even when further reactor development is taken into account additional chemical engineering effort is still needed for the economical optimization of a fission product removal plant. (auth)

40870 (DP-Report-99) THE IRRADIATION PROGRAMME OF THE DRAGON HIGH TEMPERATURE REACTOR PROJECT. Project DRAGON. Saunders, R. A. (Atomic Energy Establishment, Winfrith (England)). Jun 1962. 32p. (CONF-620604-1). Dep. CFSTI.

From Conference on Problems of Design, Building, and Operation of Experimental Devices in Research Reactors, Grenoble, France.

The purpose of the irradiation work planned in support of the Dragon Project is described. The various experiments are then discussed with particular reference to design features resulting from high temperatures and fission product release from the samples under test. Experience obtained during construction and operation of those experiments already complete is given and the future program is outlined. (auth)

40871 (DP-Report-128) THE DRAGON PROJECT ENGINEERING PROGRAMME. Project DRAGON. Franco, G. (Atomic Energy Establishment, Winfrith (England)). Dec 1962. 40p. Dep. CFSTI.

A description of various engineering aspects of DRAGON is given, including details on core design, fuel handling, heat removal and leak tightness. The organization of the engineering work is described. (auth)

40872 (DP-Report-131) THE IRRADIATION PROGRAMME: REVIEW OF RESULTS. Project DRAGON. Barr, P.; Saunders, R. A. (Atomic Energy Establishment, Winfrith (England)). Jan 1963. 44p. (CONF-630103-2). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

Results of four types of experiment are reported. (1) Graphite irradiations at RCN Petten: rigs are under construction for the irradiation of graphite to high fast neutron doses at temperatures up to 1200°C. (2) Full scale fuel irradiations: experiments in Diorit at Würenlingen are in progress using a through-core rig. A number of capsules each contain a sample of graphite tube simulating the fuel tube and fueled cartridges of identical type to those proposed for the Reactor Experiment. The thermal neutron flux and test output in this facility corresponds closely with the value expected in Dragon. A second full scale irradiation is to be carried out in Risø, the first rig is now complete. (3) Small scale irradiation of coated fuel particles under accelerated conditions: a high power density rig has been developed for irradiation in the 2-in. central hole of a Mk. III fuel element of the DR3 reactor at Risø. (4) Fission product loops in R2 Studsvik: the three parallel loops are used to study the emission of fission products from fission-product-retaining fuels. (auth)

40873 (DP-Report-213) A STUDY ON THE TRAPPING OF IODINE AT HIGH TEMPERATURES ON ACTIVATED CHARCOAL. Project DRAGON. Lingjaerde, R. O.; Podo, L. (Atomic Energy Establishment, Winfrith (England)). Sep 1963. 24p. Dep. CFSTI.

An experiment is described for the testing of iodine retention

characteristics of pure and metal coated/impregnated charcoal—in connection with the specification of internal fuel element trap filler material for the Dragon reactor. The experimental set-up is briefly outlined and results obtained from runs using pure and "treated" charcoal discussed. A theory for the mechanism of retention of iodine on pure charcoal at high temperatures is offered. Pure coconut-based charcoal gives a satisfactory performance under simulating reactor conditions and is recommended to be used for the fuel element traps in the first fuel charge. (auth)

40874 (DP-Report-216) THE DESIGN AND OPERATION OF THE INNER REFLECTOR OF THE DRAGON REACTOR. Project DRAGON. Hart, J. D. (Atomic Energy Establishment, Winfrith (England)). Sep 1963. 86p. Dep. CFSTI.

The design of the inner reflector is traced from the detailed description of the components to the material specification, through the stages of trial assembly to final erection. The full information necessary for the design of replacements of the inner columns is presented. A comprehensive photographic record of the stages of manufacture, trial assembly, and erection, and data on prototype tests and inspection records are included. The sequence of removal of the inner columns is given and a discussion on the operational limitations and safeguards is included. The dimensional changes and stresses induced in the graphite by irradiation are assessed. (auth)

40875 (DP-Report-235) RESEARCH AND DEVELOPMENT DIVISION SIXTH SEMI-ANNUAL REPORT, JANUARY 1–JUNE 30, 1963. Project DRAGON. Marien, P. (ed.). (Atomic Energy Establishment, Winfrith (England)). Nov 1963. 435p. Dep. CFSTI.

The work of the Dragon Project Research and Development Division is reported under the following headings: Reactor Physics; Heat Transfer and Gas Dynamics; Carbon Transport; Coolant Processing; Graphite; Fuel Elements; Materials, Instruments and Techniques; Component Development; Irradiation Programme; and the Seven Element Experiment. (auth)

40876 (DP-Report-255(Pt.1)) 1250 MW(TH) H.T.G.R. PRELIMINARY DESIGN STUDY. Final Report. Project DRAGON. (AGIP Nucleare, Milan (Italy). Indatom, Paris (France)). Dec 1963. 63p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

A preliminary design study is presented for a 1250 MW(t) high-temperature gas-cooled power reactor based on the use of unpurged, fission-product retaining fuel, helium coolant, and a prestressed concrete pressure vessel. (auth)

40877 (DP-Report-255(Pt.II)(Vol.1)) 1250 MW(TH) H.T.G.R. PRELIMINARY DESIGN STUDY. Final Report. Project DRAGON. (AGIP Nucleare, Milan (Italy). Indatom, Paris (France)). Dec 1963. Contract CON/WIN/52319. 121p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

A preliminary design study is presented for a 1250 MW(t) high-temperature gas-cooled power reactor based on the use of unpurged, fission-product retaining fuel, helium coolant, and a prestressed concrete pressure vessel. (D.C.C.)

40878 (DP-Report-255(Pt.II)(Vol.2)) 1250 MW(TH) H.T.G.R. PRELIMINARY DESIGN STUDY. Final Report. Project DRAGON. (AGIP Nucleare, Milan (Italy). Indatom, Paris (France)). Dec 1963. Contract CON/WIN/52319. 135p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

A preliminary design study is presented for a 1250 MW(t) high-temperature gas-cooled power reactor based on the use of unpurged, fission-product retaining fuel, helium coolant, and a prestressed concrete pressure vessel. (auth)

40879 (DP-Report-255(Pt.II)(Vol.3)) 1250 MW(TH) H.T.G.R. PRELIMINARY DESIGN STUDY. Final Report. Project DRAGON. (AGIP Nucleare, Milan (Italy). Indatom, Paris (France)). Dec 1963. Contract CON/WIN/52319. 105p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

A preliminary design study is presented for a 1250 MW(t) high-temperature gas-cooled nuclear power station based on the use of unpurged, fission-product retaining fuel, helium coolant and a prestressed concrete pressure vessel. (auth)

40880 (DP-Report-255(Pt.II)(Vol.4)) 1250 MW(TH) H.T.G.R. PRELIMINARY DESIGN STUDY. Final Report. Project DRAGON. (AGIP Nucleare, Milan (Italy). Indatom, Paris (France)). Dec 1963. Contract CON/WIN/52319. 17p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

A preliminary design study is presented for a 1250 MW(t) high-temperature gas-cooled power reactor based on the use of unpurged, fission-product retaining fuel, helium coolant, and a prestressed concrete pressure vessel. (auth)

40881 (DP-Report-268) THE DESIGN AND MANUFACTURE OF THE THERMAL COLUMN. Project DRAGON. Smith, E. (Atomic Energy Establishment, Winfrith (England)). Apr 1964. 7p. Dep. CFSTI.

40882 (DP-Report-280) SEVENTH SEMI-ANNUAL REPORT FOR THE PERIOD 1st JULY TO 31st DECEMBER 1963. Project DRAGON. Kaul, Peter (ed.) (Atomic Energy Establishment, Winfrith (England)). Jun 1964. 212p. Dep. CFSTI.

The work of the Dragon Project is reported under the following headings: reactor physics; carbon transport; coolant processing; graphite; the fuel element; materials, instruments and techniques; Engineering Research Group: irradiation program; the seven element experiment. (auth)

40883 (DP-Report-294) PITTING CORROSION IN DRAGON REACTOR GRAPHITES. Project DRAGON. Pollitt, N. (Atomic Energy Establishment, Winfrith (England)). Sep 1964. 40p. Dep. CFSTI.

This type of corrosion is catalysed by metals present in the graphite as impurities. Two methods of removing these metallic impurities from the graphite are discussed. Localised corrosion, from the use of metal clad thermocouples, is also considered. (31 references) (auth)

40884 (DP-Report-310) EIGHTH SEMI-ANNUAL REPORT FOR THE PERIOD 1st JANUARY–30th JUNE 1964. Project DRAGON. Kaul, Peter (ed.) (Atomic Energy Establishment, Winfrith (England)). Feb 1965. 180p. Dep. CFSTI.

The work of the Dragon Project is reported under the following headings: reactor physics; carbon transport; coolant processing; the fuel element; engineering and technical studies; reactor operation; assessment studies. (auth)

40885 (DP-Report-312) THE PROGRAMME OF IRRADIATION DAMAGE AND CORROSION MONITORING FOR THE PRESSURE VESSEL AND INTERNAL STRUCTURE OF THE DRAGON REACTOR. Project DRAGON. Conde, J. F. G. (Atomic Energy Establishment, Winfrith (England)). Jan 1965. 174p. Dep. CFSTI.

The basis of the program of irradiation damage and corrosion monitoring for the pressure vessel and internal structure of the Dragon Reactor is given and described in detail. The types of specimens, their preparation and canning are described together with details of their location in the reactor and the general arrangement of the various facilities which are employed to contain the specimens. Details are given of flux monitoring arrangements for thermal and fast neutron dosimetry and the proposed utilization of the test specimens and the methods for post-irradiation testing are described. (10 references) (auth)

40886 (DP-Report-325) REPORT ON WORK AT A.E.R.E. FOR THE DRAGON PROJECT, MAY–OCTOBER 1964. Project DRAGON. (Atomic Energy Research Establishment, Harwell (England). Atomic Energy Establishment, Winfrith (England)). Apr 1965. 30p. (AERE-PR/D-7). Dep. CFSTI.

Fission product release studies on DRAGON fuels irradiated in PLUTO are reviewed. Mechanical properties of HX30 graphite are measured. Fabrication of PuC_2-ThC_2 coated particle fuels is described. (15 references) (D.C.C.)

40887 (DP-Report-343) GRAPHITE SPECIMENS IN THE UPRATED ELEMENT, FIRST CHARGE POSITION 3/1. Project DRAGON. Voice, Eric H. (Atomic Energy Establishment, Winfrith (England)). May 1965. 39p. Dep. CFSTI.

It is proposed to include in the Dragon core a large number of small graphite specimens to assess their irradiation behavior and their possibilities for a future power reactor. Several series of fuel elements containing such specimens will be withdrawn after different intervals, providing various neutron doses and degrees of damage. The specimens in the first of these elements are described. Details of the nature of the graphites, the sample positions, the temperatures and fluxes anticipated, the pre-irradiation data, the methods of flux monitoring, and the post-irradiation measurements required are discussed. (13 references) (auth)

40888 (DP-Report-347) OXIDATION OF P.G.A. GRAPHITE BY TRACE MIXTURES OF CO_2/CO IN HELIUM. Project DRAGON. Bourke, P. J.; Gray, M. D.; Denton, W. H. (Atomic Energy Research Establishment, Harwell (England)). May 1965. 19p. (AERE-R-4880). Dep. CFSTI.

An investigation of the simultaneous diffusion into and reaction with P.G.A. graphite of CO_2/CO mixtures in helium is presented. CO_2 and CO pressures were varied from 10^{-4} to 10^{-3} atm and helium pressure from 10^{-1} to 1.0 atm at temperatures from 900 to 1000°C. Two cylindrical rods of graphite, machined from the same block to diameters of 1.0 and 0.2 cm, were used. From the results predictions are made of the variation in rates of

weight loss with distance from the graphite surface of coolant channels in a reactor core. Further work needed to assess more accurately the carbon transport problem and coolant purification requirements of high temperature reactors is summarized. (8 references) (auth)

40889 (NP-9383) THE DRAGON PROJECT AND ITS REACTOR EXPERIMENT. Project DRAGON. Hintermann, K. O.; Lockett, G. E.; Shepherd, L. R.; Huddle, R. A. U. (Atomic Energy Establishment, Winfrith (England)). Feb 1960. 14p. (In German). (DP-Report-3). Dep. CFSTI.

Some of the goals of the Dragon Project are discussed. The basic design parameters of the reactor experiment are tabulated, and some of the physics characteristics and fuel element and coolant properties are described. (H.D.R.)

40890 (NP-10469) THE DEVELOPMENT OF LOW PERMEABILITY GRAPHITE FOR THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Graham, L. W. (Hawker Siddeley Nuclear Power Co. Ltd., Langley (England); Watt, W.; Johnson, W. (Royal Aircraft Establishment, Farnborough (England); Arragon, P. A. P.; Price, M. S. T. (Atomic Energy Establishment, Winfrith (England)). Jun 1961. 40p. (DP-Report-40). Dep. CFSTI.

A brief description is given of the graphite core components of the O.E.E.C., High Temperature Gas-Cooled Reactor Experiment (DRAGON) and the required gas permeability characteristics outlined. Development research carried out in an endeavor to produce these components through the impregnation of a commercially available graphite using a furfuryl alcohol impregnation process is reported. In addition to giving detailed results concerning the operation of the process on a large scale, the results of experiments in which the properties of the impregnated material have been evaluated are presented. (7 references) (auth)

40891 (NP-10477) RESEARCH AND DEVELOPMENT DIVISION FIRST SEMI-ANNUAL REPORT FOR PERIOD JULY 1, 1960 TO DECEMBER 31, 1960. Project DRAGON. Marien, P. (ed.) (Atomic Energy Establishment, Winfrith (England)). Jun 1961. 356p. (DP-Report-34). Dep. CFSTI.

The work of the DRAGON Project Research and Development Division is reported under the following headings: Theoretical Studies; Reactor Safety and Kinetics; Experimental Reactor Experiments; Heat Transfer Experiments; Carbon Mass Transfer; Coolant Processing; Fission Products; Graphite; Fuel Elements; Materials, Instruments and Techniques; Component Development; In-pile Experiment; The Seven Fuel Element Experiment. (auth)

40892 (TRG-Report-1911) FAST REACTOR IRRADIATION TESTING. Proceedings of the International Conference held at Thurso, Caithness, Scotland, 14th-17th April, 1969. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 605p. (CONF-690427). UK 4 pounds, 10s.

The development programs for fast reactors and fast neutron radiation testing facilities are reviewed. Separate abstracts are presented for 33 of the 34 papers included. One paper has been previously abstracted and is found in the NSA Report Number Index as CEA-CONF 1321. (D.C.C.)

For abstracts of individual papers see: 40722, 40893–40902, 40926, 41009–41015, 41032–41034, 41045–41054, and 41063.

40893 (TRG-Report-1911, pp 13-25) IRRADIATION TESTING IN FAST REACTORS IN THE UNITED KINGDOM. Lawton, H.; Birss, I. R. (United Kingdom Atomic Energy Authority, Sellafield (England). Reactor Group); Bagley, K. Q. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group).

The criteria established for the successful use of DFR for irradiation purposes, and the advantages of using a fast reactor are discussed. Examples are drawn from the PFR program for testing fuel, cladding, pins and assemblies, and from tests in support of thermal systems under development. Lack of instrumentation in the experimental rigs results in particular importance being placed on post-irradiation examination and on interpretation of the data. One advantage of DFR is that experiments may be examined non-destructively and returned to the reactor for further irradiation. An indication is given of the proposed use of PFR for experimental purposes, of how this will differ from the current use of DFR, and of its capabilities. (UK)

40894 (TRG-Report-1911, pp 36-43) CONSIDERATIONS IN AN IRRADIATION-EFFECTS PROGRAMME FOR FAST-REACTOR STRUCTURAL MATERIALS. Grounes, M.; Ljungberg, L. (Aktiebolaget Atomenergi, Studsvik (Sweden)).

Swedish fast reactor work, which is briefly described, is concerned mainly with design and irradiation experiments on pressure vessels and cladding materials. Much preliminary irradiation work was carried out in a thermal materials testing reactor R2. For problems on void formation in cladding materials, where high-dose irradiations are required, a special experiment with ^{10}B-containing material was designed to investigate the effects of helium. Future experiments will be based on fast reactor irradiation when facilities are available. 9 references (UK)

40895 (TRG-Report-1911, pp 116-41) THE MEANING OF IRRADIATION EXPERIMENTS IN FAST REACTORS FOR THE DEVELOPMENT OF MATERIALS FOR HTG-REACTORS. Pott, G.; Delle, W. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe).

In order to predict the behaviour of materials in high-temperature gas-cooled reactors, the effect of fast neutron irradiation must be known. Commercial graphites were irradiated in DFR to maximum doses of 0.7×10^{22}nvt (E > 0.1 MeV). Results are given for changes of density, expansion, thermal and electrical conductivity, and Young's modulus, for both isotropic and anisotropic materials. The irradiation behaviour of coated particles, with an outer layer of isotropic pyrolytic carbon and an inner porous layer, is described. (UK)

40896 (TRG-Report-1911, pp 346-74) IRRADIATION RIGS FOR THE DOUNREAY FAST REACTOR. Pounder, J. O.; Brindley, K. W.; Diggle, R. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group); Forgan, R.; George, M. W. (Atomic Energy Research Establishment, Harwell (England)); Leet, G. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group).

The design of irradiation rigs is described. Problems encountered in their manufacture, and some safety aspects, are discussed. Several of the large numbers of available rigs were selected to illustrate the progression of the designs from simple single-pin non-instrumented rigs, to sub-assemblies of fuel pins and complex instrumented rigs. (UK)

40897 (TRG-Report-1911, pp 377-86) INTERPRETATION OF DISPLACEMENT DAMAGE IN IRRADIATION-EFFECTS STUDIES ON STRUCTURAL MATERIALS IN A FAST REACTOR. Grounes, M.; Lindhagen, P. (Aktiebolaget Atomenergi, Studsvik (Sweden)).

Displacement damage in structural materials is due to the formation of cascades of vacancies and interstitials during fast-reactor irradiation at temperatures below about 400°C. Work on both fast-reactor, and thermal-reactor structural materials may be of interest in connection with fast-reactor irradiations either in order to obtain irradiation conditions similar to those in an actual component or in order to decrease the irradiation time needed to obtain a given neutron dose. In order to determine how results from experimental data obtained in one neutron spectrum may be applied to components which will be exposed to another spectrum, comparisons between displacement damage in different spectra of interest were made on the basis of calculations according to different damage models. (14 references) (auth) (UK)

40898 (TRG-Report-1911, pp 402-10) PROBLEMS IN THE IRRADIATION BEHAVIOUR OF LMFBR CORE MATERIALS. Murray, P. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.).

The phenomena of clad swelling and its significant role in fuel rod behaviour is discussed, with particular reference to 304 and 316 stainless steel cladding. Predictions of creep strain and failure are considered. Attention is drawn to the different fluence/burnup ratios in LMFBR's compared with test reactor conditions, and to the need for determination of saturation limits for clad swelling. (8 references) (UK)

40899 (TRG-Report-1911, pp 458-72) TEMPERATURE MEASUREMENTS IN UNINSTRUMENTED D.F.R. EXPERIMENTS. Bramman, J. I.; Fraser, A. S. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group); Martin, W. H. (United Kingdom Atomic Energy Authority, Culcheth (England). Reactor Group).

The present status of various monitoring devices is reviewed. These include fusible alloy monitors, bimetal thermometers and clinical thermometers for maximum temperatures; silicon carbide monitors and ^{85}Kr tracers for end-of-run temperatures; templugs and the use of ageing-phase growth in a precipitation-hardening Ni-Fe alloy, for average temperatures. Important features of each are summarised. The use of a continuous recording device is considered. (UK)

40900 (TRG-Report-1911, pp 473-99) THE USE OF D.F.R. FOR SOME MATERIALS IRRADIATION EXPERIMENTS OF SIGNIFICANCE TO THERMAL AND FAST REACTOR DESIGNS. Standring, J.; Wood, D. S.; Martin, W. H. (United Kingdom Atomic Energy Authority, Culcheth (England). Reactor Group).

Observed effects of stainless steel canning materials irradiated in a fast neutron spectrum are described. These are point defect hardening, high temperature embrittlement, changes in metallurgical structure and dimensional changes caused by production of internal voids. The criterion of irradiation damage for SGHWR pressure tubes irradiated in DFR is discussed and fast fracture and creep studies on Zr-2 and Zr-2½% Nb are reviewed. The concept of equivalent neutron dose and temperature for the application of DFR data to AGR graphite is described and it is shown how graphite irradiations in DFR may be correlated with those in DIDO. 31 references. (UK)

40901 (TRG-Report-1911, pp 531-44) THE P.F.R. IRRADIATION FACILITIES. Jackson, G. O. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group).

Facilities include six demountable sub-assemblies each containing six fuel clusters which can be independently loaded, in situ, in the reactor for fuel or for cladding irradiations. They are arranged in two rings of radii 43 cm and 52 cm from the core centreline, where the maximum fluxes are 6.7×10^{15} and 5.9×10^{15} n.v.t. resp. Fissile heaters for the materials irradiation rigs give temperatures of 450 to 700°C and a maximum of 2 years continuous irradiation. Clusters from the sub-assemblies may be irradiated to destruction in fuel failure rigs housed in four of the reactor core support positions. Instrumented rigs loaded through direct access holes in the rotating shield will measure coolant, can and fuel temperatures in typical sub-assembly arrangements. (UK)

40902 (TRG-Report-1911, pp 545-63) A POSSIBLE MATERIALS-TESTING FAST REACTOR (M.F.R.). Constantine, G.; Crocker, V. S.; Frost, B. R. T.; George, M. W. (Atomic Energy Research Establishment, Harwell (England)).

Full details and parameters are presented of a new concept for providing irradiation facilities appropriate to the development of fast power reactors. The materials testing fast reactor described is a 118 MW(+) PuC/^{238}UC fuelled, Na cooled reactor, with a central flux of 1.1×10^{16} N/cm^2/sec., height 30.5 cm, and mean dia. 55.9 cm. A unique design feature is the complete segregation of fuel and experiment handling, the core being on one arm of a rotor which can move vertically and transfer the entire core to a refuelling station within the coolant pool. Small highly-instrumented experiments may thus be irradiated in high fast-neutron fluxes. Experiments at or below room temperature can be accommodated without excessive coolant problems, and fuel cladding operates at temperatures at which it has high strength and low incidence of void formation. (UK)

40903 FUTURE DEVELOPMENT TASKS IN THE FAST BREEDER REACTOR PROJECT. Engelmann, P. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 15: 334-6(Jul 1970). (In German).

European projects for development of fast breeder reactors are surveyed. A prototype fast sodium-cooled reactor of 300 MW will be finished in 1976. Completion of the first commercial fast sodium-cooled breeder of 600 to 1000 MW is planned for 1980. Improved sodium-cooled high-power fast breeders are projected for 1990. Developmental work is done by a combination of nuclear centers with industrial companies. At the nuclear research centers basic research is conducted especially with respect to physics, thermohydraulics, safety, material, and fuel elements. The present state of the projects is discussed. (H.B.G.

40904 ENERGETICHESKAYA, ATOMNAYA, TRANSPORTNAYA I AVIATSIONNAYA TEKHNIKA. KOSMONAVTIKA. (Power, Nuclear, Transport, and Aviation Technology. Interplanetary Navigation). Nesteruk, F. Ya.; Ostol'skii, Vs. I. (eds.). Moscow; Izdatel'stvo Nauka (1969). 472p.

A review is given of fifty years of progress in electrical and nuclear power in industry, agriculture, naval and aviation transportation, and cosmic flights. Conventional power plants, hydroelectric power plants, and the new sources of electric power (magnetohydrodynamics, solar, geothermal, etc.) are discussed. Nuclear power plants, techniques in the nuclear industry, isotopes, and nuclear emissions are covered. Various types of transportation, railroad, automobile, and water are examined. The aviation techniques, rockets and cosmic flights are discussed. Extensive bibliographies are included. (R.V.J.)

40905 FAST BREEDER REACTORS STATUS AND PROSPECTS. Murphy, P. M. (General Electric Co., Sunnyvale, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 10-15(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CCNF-691017-(Pt.1).

The history of the worldwide development of fast breeder reactors is reviewed. Some of the incentives and problems related to fast breeder reactor development are discussed. (D.C.C.)

Kinetics and Dynamics

40906 (AEEW-R-691) REACTOR PERFORMANCE CALCULATIONS FOR WATER REACTORS. Hicks, D. (Atomic Energy Establishment, Winfrith (England)). Apr 1970. 243p. Dep. CFSTI (U. S. Sales Only).

The principles of nuclear, thermal and hydraulic performance calculations for water cooled reactors are discussed. The principles are illustrated by describing their implementation in the UKAEA PATRIARCH scheme of computer codes. (auth) (UK)

40907 (DP-Report-74) A ONE DIMENSIONAL ANALYTICAL SIX GROUP CRITICALITY PROGRAMME. Project DRAGON. Kalnaes, O.; Massimo, L. (Atomic Energy Establishment, Winfrith (England)). Feb 1962. 23p. Dep. CFSTI.

A detailed account of the theory on which the programme is based is given together with descriptions of input data, printout and operating instructions. Examples of input data and results are also given. (auth)

40908 (DP-Report-156) A COMPARISON OF CODES FOR SPECTRUM AND REACTIVITY CALCULATIONS. Project DRAGON. Massimo, L.; Micheelsen, B. (Atomic Energy Establishment, Winfrith (England)). Feb 1963. 17p. (CONF-630511-18). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

A comparison of sets of codes for calculation of spectrum, broad group cross sections, and reactivity is described. The comparison shows the significance of the leakage term (the buckling) introduced into the spectrum code and the disadvantages of the group partition used when this comparison was performed. A number of differences of the basic input cross sections are described. (5 references) (auth)

40909 (DP-Report-158) THE PRESENT POSITION OF REACTOR KINETIC STUDIES ON THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Blake, J. P. H. (Atomic Energy Establishment, Winfrith (England)). Feb 1963. 42p. (CONF-630511-4). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

Details of work done for safety considerations are presented. The relationship between safety and reactor kinetics is discussed, and results are given in some cases of interest. Methods of calculation are described, and the data used are discussed and tabulated. (10 references) (auth)

40910 (DP-Report-159) THE SIGNIFICANCE OF THE BUCKLING FOR THE SPECTRUM AND THE GROUP CROSS SECTIONS. Project DRAGON. Micheelsen, B. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 32p. (CONF-630511-19). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

As the effect of the buckling on the spectrum calculation is found significant for the Dragon reactor, a method is proposed for the determination of the appropriate bucklings which are to be used in the spectrum code. The method is iterative as it is using bucklings calculated from preceding diffusion group calculations. The resulting bucklings are dependent on the group energies. The utilization of these bucklings involve approximations which are least when only small regions are investigated. The behavior of the bucklings as functions of energy, the significance for the group cross sections, and the multiplication factor is discussed. A comparison is performed of the spectrum obtained by the aid of the buckling method and by a one-dimensional multi-group diffusion theory code. (8 references) (auth)

40911 (DP-Report-166) PHYSICS EXPERIMENTS ON THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Blake, J. P. H.; Della Loggia, V. E.; Reber, J. (Atomic Energy Establishment, Winfrith (England)). Mar 1963. 19p. (CONF-630511-5). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

Physics information obtainable from the Reactor Experiment is presented. Various possible experimental techniques are briefly discussed. The main efforts required on the theoretical side are also considered, consisting mainly of analysis of kinetic experiments at the present time. (19 references) (auth)

40912 (DP-Report-170) PROPOSALS FOR TRANSFER FUNCTION MEASUREMENTS ON THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Reber, J. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 22p. (CONF-630511-22). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

Details of the reactor physics information available from transfer function measurements are presented. The experiments considered are the reactivity of flux transfer function

at different power levels and the inlet to outlet helium temperature transfer function. Different methods of their measurement are described and discussed with respect to their relationship to the irradiation programme and their experimental usefulness. (18 references) (auth)

40913 (DP-Report-171) SIMPLIFIED CALCULATIONS OF DIFFERENT DRAGON POWER TRANSFER FUNCTIONS. Project DRAGON. Hage, W. (Atomic Energy Establishment, Winfrith (England)). Mar 1963. 15p. (CONF-630511-13). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

The control rod oscillator method is useful to calibrate control rods to determine the prompt neutron lifetime at zero reactor power, and to determine heat conduction and heat transfer coefficients at power. The difference between the zero power and power transfer functions is due to temperature coefficients associated with the different zones of the reactor. Equations for the dynamic behavior of the reactor are presented. The influence of the assumed heat conduction models of the fuel elements on the power transfer function is analyzed. The fundamental terms of the sinusoidal temperature variations effecting the temperature feed back on the transfer function are calculated with the heat diffusion equation for cylindrical geometry. The corresponding thermal stresses (plane strain) are calculated for a homogeneous cylindrical fuel element, with isotropic heat and elasticity properties. The derived equations exclude heat radiation and refer to a time independent mean axial coolant temperature. (auth)

40914 (DP-Report-172) MUPO: AN IBM-7090 PROGRAMME TO CALCULATE NEUTRON SPECTRA AND MULTI-GROUP CONSTANTS. Project DRAGON. Schloesser, J. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 22p. (CONF-630511-24). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

MUPO calculates the zero dimensional neutron spectrum in 43 energy groups. This spectrum is used to evaluate condensed microscopic cross sections for various other programs. 9 references. (auth)

40915 (DP-Report-176) LIFETIME OPTIMISATION OF A CORE SUITABLE FOR LONG TERM IRRADIATION EXPERIMENTS. Project DRAGON. Massimo, L. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 22p. (CONF-630511-17). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

The radial distribution of ^{235}U and Th have been optimized in order to give the best power distribution at any moment of life with the requirement of having a few fuel elements in conditions similar to those of a big power reactor. Existing computer codes have been modified in order to perform this assessment. 6 references. (auth)

40916 (DP-Report-177) THE FIRST LOADING OF THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Schroeder, E.; Blomstrand, J.; Bruneder, H.; Massimo, L.; Micheelsen, J.; Schloesser, J. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 45p. (CONF-630511-25). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

The arguments leading to the final proposal for the first core are outlined. Calculations of reactivity, temperature coefficient and control rod effectiveness are given with an assessment of the probable error. (auth)

40917 (DP-Report-179) POWER DISTRIBUTION AND CORE TEMPERATURES IN THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Blomstrand, J. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 30p. (CONF-630511-7). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

The influence of different uranium loadings and uranium and thorium distributions on the power distribution and temperatures in the Dragon core are investigated and the results are discussed. 11 references. (auth)

40918 (DP-Report-181) NEW CALCULATIONS ON THE SECOND LOADING OF THE ZENITH REACTOR. Project DRAGON. Micheelsen, B. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 33p. (CONF-630511-20). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

Calculations for the second loading of the Zenith reactor are compared with experiments. The latest codes and methods have been used and are briefly described. The calculated reactivity of the cold reactor is in very good agreement with the experiment. The methods of calculation for the control rod effectiveness introduced during this work have led to very satisfactory results. Reactivity temperature coefficients are calculated and a good result is obtained for the core temperature coefficient. The calculated reflector temperature coefficient is less accurate, and so is the calculated effect of graphite fillers. The difference between calculated and measured results are discussed, and an estimate of the uncertainty of the reactivity calculation is given. 14 references. (auth)

40919 (DP-Report-190) REACTOR PHYSICS AND HEAT TRANSFER WORK IN THE DRAGON PROJECT. Project DRAGON. Hintermann, K. O. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 7p. (CONF-630511-14). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

40920 (DP-Report-210) MULTIPLICATION FACTOR DEFINITIONS THEORY AND EXPERIMENT. Project DRAGON. Micheelsen, B. (Atomic Energy Establishment, Winfrith (England)). Sep 1963. 24p. Dep. CFSTI.

Definitions used for the effective multiplication factor in theoretical and experimental work are investigated. The experimental procedure of measuring k_{eff} is the balance method. Following in calculation the recommendations (definition) of the experimentalists a calculated value of the experimental value of k_{eff} can be obtained for a simple reactor model. Comparison of k^{T}_{eff} with the theoretical value k^{T}_{eff} obtained by the source iteration procedure shows that the two values can be large for a reactor with high reactivity. The reason for the difference is that the experimental (actual) reactor is always very near criticality while the theoretical value k^{T}_{eff} for the unrodded reactor is a fictional quantity. It is concluded for that reason that discussions and comparison of k_{eff} value significantly larger than 1 should be avoided. 6 references. (auth)

40921 (DP-Report-261) THE NEW CROSS SECTION LIBRARY OF THE DRAGON PROJECT. Project DRAGON. Nyffenegger, U.; Schloesser, J. (Atomic Energy Establishment, Winfrith (England)). Feb 1964. 20p. Dep. CFSTI.

A description of the new cross section library for the Dragon Reactor physics group is given. Some of the results obtained with the new library are compared with previous results. 14 references. (auth)

40922 (DP-Report-267) LOADING CALCULATIONS FOR THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Gutmann, H.; Micheelsen, B.; Preinreich, G. (Atomic Energy Establishment, Winfrith (England)). Apr 1964. 94p. Dep. CFSTI.

The effective multiplication factor for various core patterns obtained during the loading of the Dragon Reactor is calculated. Some of the cores considered consist of few fuel elements and it was necessary to use transport calculations and calculations taking the azimuthal variation into account to reach reasonably accurate results. The effects of the large spectrum changes for such loadings were also considered. The final results given include the effective multiplication factor for the unrodded reactor, the control rod effectiveness as function of number of rods, the reactivity worth of a fuel element in the center of the core, and the reactivity worth of a nitrogen gas in the reactor. 18 references. (auth)

40923 (DP-Report-289) THE PHYSICS COMMISSIONING PROGRAMME FOR THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Blake, J. P. H. (Atomic Energy Establishment, Winfrith (England)). Aug 1964. 28p. Dep. CFSTI.

The Dragon Project proposals for the physics commissioning program of the Reactor Experiment are described and classified. Information on the expected time for this program, if continuously performed, and a brief description of the special experimental equipment are given. (auth)

40924 (JAERI-1192) PROF GROUCH-G: A PROCESSING CODE FOR GROUP CONSTANTS FOR A FAST REACTOR. Tone, Tatsuzo; Katsuragi, Satoru (Japan Atomic Energy Research Inst., Tokai, Tokai Research Establishment). Nov 1969. 22p. Dep. CFSTI (U. S. Sales Only).

The code PROF GROUCH-G was developed for producing fast reactor group constants by processing directly the nuclear data given by ENDF/A formats. Types of group constants obtained by the code are similar to the Russian group-constants set, but the processing and calculation methods were improved in comparison with those of the conventional group-constants sets published so far. The characteristic features of the code are as follows: (1) All data of DCC 1, 2, 6, 9 and 10 formats can be treated. (2) Calculations of different nuclides, reaction and data types can be continuously carried out, and the respective results are obtained. (3) For the angular distribution data of elastic and inelastic scattering, the energy transfer probabilities are in detail calculated by using the conservation law of momentum and energy. (4) Smooth spectra $\phi_s(E)$ used for averaging cross sections are fission spec-

trum and $1/E^{\alpha}$. Composition dependence of cross sections is taken into account by using a spectrum $\phi_s(E)$ $(\sigma_t(E) + \sigma_\phi)^{-1}$. UKNDL and ENDF/B data also can be processed, because codes converting them into ENDF/A formats were developed. The PROF GROUCH-G is written for IBM-360/75 and FACOM-230/60. (auth) (Japan)

40925 (RT/FI-(70 1) PHYSICAL FOLLOW-UP OF EBWR OPERATION BY NUCLEAR CODES DEVELOPED BY CNEN. 2nd PART. BURN-UP AND POWER DISTRIBUTION CALCULATIONS. Coari, P.; Lopez, S.; Michelini, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 21 Nov 1969. 63p. Dep. CFSTI (U. S. Sales Only).

The physical follow-up of the EBWR plant operation is discussed regarding: (1) reactivity and power distributions during burnup; (2) revision of the preceding K_{eff} calculations; and (3) minimum Pu critical after final shutdown. (auth)

40926 (TRG-Report-1911, pp 387-401) THE ASSESSMENT OF REACTOR DATA IN THE DOUNREAY FAST REACTOR. Dehn, R.; Horrocks, T. F.; Sussock, H. C. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group).

The parameters of major interest for knowledge of the operating characteristics of the reactor are neutron and γ flux and spectrum, reaction rates in fuel isotopes, damage and transmutation rates in non-fissile materials, and temperature and flow rates of the primary coolant. Calculations of this information, which lead to assessments of conditions in experiments in the reactor, are described and uncertainties in the results are discussed. 22 references. (UK)

Control Systems

Refer also to abstracts 39394 and 41066.

40927 (DP-Report-122) ABSORBER ROD CONTROL CIRCUIT. Project DRAGON. Caldarola, L.; Dondi, G.; Dean, J. R. (Atomic Energy Establishment, Winfrith (England)). Oct 1963. 64p. Dep. CFSTI.

The Dragon reactor is controlled by twenty-four absorber rods, containing boron carbide, arranged in the reflector as a curtain round the core. The rods and their drive mechanisms are all identical. The mechanisms are linked to the electrical control circuit through the special stepping motors and the limit and load sensing switches, and the circuit determines the way in which the rods are employed in controlling the reactor. The control functions of the system and particulars of the electrical equipment and circuits are described. (auth)

40928 (DP-Report-168) EQUIPMENT FOR THE REACTOR PHYSICS EXPERIMENTAL PROGRAMME IN THE DRAGON REACTOR. Project DRAGON. Della Loggia, V. E. (Atomic Energy Establishment, Winfrith (England)). Mar 1963. 16p. (CONF-630511-16). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

The instrumentation needed for the Dragon Reactor physics experimental program is reviewed. An outline is also given of that part of the permanently installed reactor instrumentation which can be used for the same experimental program. 9 references. (auth)

40929 (DP-Report-174) DRAGON REACTOR AUTOMATIC CONTROL. Project DRAGON. Caldarola, L. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 51p. (CONF-630511-9). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

The relationships of the reactor operating parameters are analyzed to establish which should be varied directly to achieve overall control. Comparisons on the basis of general performance and stability are made between two methods of controlling helium outlet temperature, one working from direct measurement of temperature error and the other from measurement of flux and the integral of temperature error. The latter has been chosen to be installed in the Dragon reactor. Its circuits are described. (auth)

40930 (DP-Report-178) CONTROL ROD CALCULATIONS FOR THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Blomstrand, J. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 18p. (CONF-630511-6). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

The methods for calculation of control rod influence on reactivity in Dragon are presented and the results from the calculations are discussed. 10 references. (auth)

40931 (DP-Report-191) A NOZZLE THERMOCOUPLE FOR MEASUREMENTS IN HIGH TEMPERATURE GASES. Project DRAGON. Dalle Donne, M.; Bowditch, F. H. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 21p. (CONF-630511-12). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

The thermocouple dispenses with wires having the thermojunction in the walls of the hollow probe itself. It consists of a Venturi tube of which the convergent section is made of platinum and the divergent section of platinum-I hodium, the two materials being welded at the throat of the Venturi. The instrument is suitable for temperatures up to 1600°C but requires careful use at the higher temperatures. 11 references. (auth)

40932 (RT/FI-(69)51) MODEL OF SELF CONTROL THROUGH BOILING IN POWER EXCURSIONS OF A WATER COOLED REACTOR. Michelini, M.; Petrarca, S. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 14 Nov 1969. 49p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The negative void coefficient provides a useful self-control in the power excursions of water moderated reactors. A model is presented which allows the calculation of the reactivity effect produced by sub-cooled boiling during excursions in pool water reactors at source power level. An application was carried out by means of analog computer. (auth)

40933 (RT/FI-(70)20) STUDY OF THE USE OF Gd IN A BOILING WATER REACTOR. Coari, P.; Lopez, S. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 9 Apr 1970. 68p. (In Italian). Dep. CFSTI (U. S. Sales Only).

Gd addition to the fuel makes possible the reduction of the control system dimension in a nuclear reactor. A design calculation of Gd addition to a Pu fuel assembly of the type employed in a BWR is presented. This study points out that a reduction of control system dimension of 75% can be achieved by means of Gd addition. Power distribution alteration is not so large as to proceed again to a new optimization study of the fuel element. (auth)

40934 PRESSURE MEASUREMENT INSTRUMENT FOR LIQUID METAL REACTORS. Billeter, T. Roger; Brown, D. P.; Spear, W. G. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 495-500(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The theory of operation and initial experimental results presented pertain to a microwave frequency pressure sensor applicable to measurements within liquid metal cooled, fast breeder reactors. The basis of operation of the pressure sensor depends on the deflection of one end wall of a cylindrical microwave cavity and on the measurement of the resultant change of cavity resonant frequency. Temperature dependence of the sensor output signal is significantly reduced by measuring the difference frequency between two identical resonant cavities. The dual cavity (1.9-cm long by 3.3-cm diameter) sensor yielded nearly linear response over the temperature range 75 to 1200°F and for pressures up to one atmosphere, with sensitivities of 0.5 and 0.8 MHz/psi at 75 and 1200°F, respectively. The 0.015-cm thick stainless steel diaphragm also responded without permanent deformation for applied pressure of 45 psi. Pressure sensor time response to abrupt changes of pressure equals about 7.5 ms. The sensor and associated transmission waveguide fabricated of metal only should be immersible in the liquid metal coolant. 4 references. (auth)

40935 REACTOR POWER MONITOR BASED ON CHERENKOV RADIATION DETECTION. Porges, K. G.; Gold, R.; Corwin, W. C. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 501-5(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A detection channel is proposed based on sensing the gamma flux above some energy threshold, thus discriminating against gamma radiation associated with decay. In addition, the proposed system dispenses with cables and voltages applied across damageable insulators, through sensing the light transmitted along a cylindrical duct. The detecting medium is the gas with which the duct is filled; the light signal is the Cherenkov radiation generated by relativistic Compton recoil electrons. Cherenkov radiation intensity increases sharply from an electron velocity threshold, which depends on the index of refraction of the medium. For gases, this threshold can be continuously varied by adjusting the gas pressure. On the other hand, electrons with subthreshold velocities can generate (background) light through scintillation processes. In order to assay the overall discrimination available from the choice of gas, pressure, and geometry, a series of tests has been under way with 3-MeV electron pulses from a Van de Graaff accelerator. The detector used in these tests was filled with various gases at pressures ranging from 0 to 1000 psi, and the intensity of photomultiplier pulses was recorded as a function of pressure, by means of an address-averaging system fed by an ADC; photomultiplier pulses were gated by the accelerator. Measurements made thus far with a few gases show excellent agreement with theoretically

calculated Cherenkov yields and demonstrate a rise of more than two orders of magnitude in intensity from threshold. 6 references. (auth)

40936 ANALOG SIGNAL PROCESSOR AND DISPLAY FOR REACTOR SYSTEMS WITH DISCRETE MEASUREMENTS. Schweizer, P. F. (Westinghouse Electric Corp., Pittsburgh). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 524-31(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

An electronic signal processor is described which, in general, may be applied to approximate a distributed variable from discrete measurements. The processor also determines the optimum location for the discrete measurement transducers which results in the best approximation to the distributed variable. A particular application is presented which demonstrates how the processor may be applied to determine an in-core neutron flux distribution from in-core detectors located within the core of a pressurized-water reactor. 3 references. (auth)

40937 CONTROL SYSTEM STABILITY IN SPATIALLY LARGE CORES. Raju, G. V. S. (Ohio Univ., Athens); Stone, R. S. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 534-40(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

An analytical transfer function model is derived for a coupled-core reactor, with an independent control system for each core. Using this model, the stability of the overall system is studied by the modified Nyquist criterion. For given reactor parameters, stability limits are found to be identical to those for a point reactor. 10 references. (auth)

40938 NONINTERACTING CONTROL SYSTEM DESIGN FOR A COUPLED CORE NUCLEAR REACTOR. Raju, G. V. S.; Stelzer, M. A. (Ohio Univ., Athens). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 541-8(Feb 1970),

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A procedure is presented to design a noninteracting control system for a coupled-core nuclear reactor. Simple methods are given to compute Q matrix and compensation. A computer program is developed to facilitate the design for large nuclear reactors. 8 references. (auth)

40939 ROOT LOCI APPROACH IN THE STUDY OF STABILITY OF LINEAR HOMOGENEOUS SPACE-TIME REACTORS. Hsu, C.; Habegger, L. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 549-54 (Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The stability of linear homogeneous distributed-parameter reactor systems is analyzed using the familiar root-loci method commonly used by control system engineers. The result provides information on the absolute stability as well as the relative stability of the reactor systems. 4 references. (auth)

40940 IN-CORE NEUTRON MONITORING SYSTEM FOR GENERAL ELECTRIC BOILING WATER REACTORS. Morgan, W. R. (General Electric Co., San Jose, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 564-71 (Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A general description of the neutron monitoring system is presented. The functions and neutronics response of each subsystem are described. The operational and safety functions are discussed and a description of the detectors and signal conditioning electronic functions is given. (auth)

40941 TWO-RANGE SYSTEM FOR EX-CORE NEUTRON FLUX MONITORING. Johnson, L. M.; Meijer, C. H. (Combustion Engineering, Inc., Windsor, Conn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 572-80(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The neutron flux monitoring system described applies the concept of wide and narrow range (two groups of instruments) monitoring of the neutron flux instead of using three ranges or groups of instruments. The system uses a total of ten channels which are subdivided into four wide-range logarithmic channels monitoring the neutron flux from source level to full reactor power level, and six linear power range channels monitoring the neutron flux from approximately 0.1 percent to full reactor power level. The four wide-range channels operate from a combination of proportional counters and fission chambers. A single output signal from each channel is produced by pulse counting techniques for the first five decades of flux values, and by mean square variation techniques up to full reactor power. This method reduces errors due to gamma background as well as resolution counting loss errors normally associated with high rate counting. The four wide-range logarithmic channels provide rate-of-change-of-power information to four reactor protective channels. The narrow (linear power) range channels operate from dual-section uncompensated ionization chambers, each section covering one half (axially) of the reactor core. The output signals of each section are processed and evaluated by two identical subchannels for core flux conditions. Four of the linear power range channels provide power information to four reactor protective channels; two are used for reactor control channels. (auth)

40942 COMMON MODE FAILURE STUDY DISCIPLINE. Jacobs, I. M. (General Electric Co., San Jose, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 594-8(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A Common Mode Failure (CMF) study is described which supports the design basis for the reactor protection system on a boiling water reactor. Ground rules are formulated which restrict the study to functional CMFs applied one at a time to a reactor plant subjected to initiating transients and accidents. Each outcome is traced to a stable condition and the results examined to determine that they are acceptable. CMF studies seem to parallel the development of reliability studies and the results appear to be complementary. (auth)

40943 SOME ASPECTS OF THE PROCESS CONTROL AND PROTECTION SYSTEMS OF A WESTINGHOUSE PWR. Spurgin, A. J. (Westinghouse Nuclear Energy Systems, Pittsburgh). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 599-607(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Some of the control and protection systems of a PWR are described. The behavior of the reactor during load change transients is depicted and the response of some of the control systems is given. The criteria used in the design of the protection system and the relationship of the various standards to the design are discussed. The application of these criteria to the protection system is illustrated by the use of two typical protection systems. Future developments in the field are considered. 3 references. (auth)

Shielding

40944 (DP-Report-175) PROGRESS IN SHIELDING DESIGN IN THE DRAGON PROJECT. Project DRAGON. Crawley, D. B. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 50p. (CONF-630511-10). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

The work that was carried out on the Dragon shield design problems is summarized. Preliminary investigations into the shielding requirements for a 1250 MW high temperature power reactor design study are described. (auth)

40945 (DP-Report-296) FINAL SHIELDING REPORT FOR THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Crawley, D. B.; Owen, O. R. (Atomic Energy Establishment, Winfrith (England)). Sep 1964. 198p. Dep. CFSTI.

The final shielding report for the Dragon Reactor Experiment includes the revised contents of the preliminary report and examines the ultimate design of the reactor components. Fission product retaining fuel proposed for the core charge allows some relaxation of shielding in the area of the core. Radiation damage to reactor materials, and the access to maintenance areas after shutdown are considered. The Appendix contains data required by the Mercury Computer shielding programs. 28 references. (auth)

40946 (DP-Report-353) STRESS CONCENTRATION ADJACENT TO REINFORCED CIRCULAR PENETRATIONS CLOSELY PITCHED TRANSVERSELY TO A UNIDIRECTIONAL STRESS WITH SPECIAL REFERENCE TO PRESTRESSED CONCRETE REACTOR VESSELS. Project DRAGON. Kinkead, A. N. (Atomic Energy Establishment, Winfrith (England)). Sep 1965. 30p. Dep. CFSTI.

The maximum stresses given by the theoretical analysis are expected to have slightly higher values than those occurring in nature and hence the theory should be inherently safe to use. In certain important problems requiring an exact solution the theo-

retical values obtainable from the new theory may be used as very advanced starting points for a reiterative relaxation method final stage smoothing of the results. The new approach has also the advantage of extreme simplicity. (14 references) (auth)

40947 (NP-9742) PRELIMINARY SHIELDING REPORT FOR THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Crawley, D. B. (Atomic Energy Establishment, Winfrith (England)). Nov 1960. 151p. (DP-Report-6). Dep. CFSTI.

The main and secondary reactor shielding designs are described. Dose rates from different parts of the reactor under normal operating conditions, fault conditions, and fuel element discharge are calculated. The dose rate at shutdown in inner sections of the reactor is analyzed, and nuclear heating and activation of structural components are examined. (H.D.R.)

Cooling Systems

Refer also to abstracts 39130 and 39170.

40948 (DP-Report-88) HIGH TEMPERATURE HEAT TRANSFER CIRCULAR CHANNEL EXPERIMENT. LOCAL HEAT TRANSFER AND AVERAGE FRICTION COEFFICIENTS FOR SUBSONIC LAMINAR, TRANSITIONAL AND TURBULENT FLOW OF AIR IN A TUBE AT HIGH TEMPERATURE. Project DRAGON. Dalle Donne, M.; Bowditch, F. H. (Atomic Energy Establishment, Winfrith (England)). Mar 1962. 86p. Dep. CFSTI.

Experimental results for laminas, transitional, and turbulent flow of air through circular tubes are presented. The data are correlated in terms of dimensionless numbers and compared with other experiments. The manner in which the data may be applied to Dragon Reactor calculations is indicated. 44 references. (auth)

40949 (DP-Report-95) SOME METALLURGICAL PROPERTIES OF THE DRAGON REACTOR PRESSURE VESSEL. Project DRAGON. Conde, J. F. G. (Atomic Energy Establishment, Winfrith (England)). May 1962. 56p. (CONF-620503-1). Dep. CFSTI.

From Symposium on Steel in Nuclear Engineering, Studsvik, Sweden.

The nature of the Dragon Reactor Experiment and the form, service conditions and materials of the reactor pressure vessel are described briefly. The significance of various metallurgical properties in relation to the service conditions of the reactor pressure vessel is discussed. A detailed account of mechanical property, creep and fatigue testing and brittle fracture tests carried out on the pressure vessel materials and the results of such tests are presented. The results are given of an accelerated dose irradiation program designed to investigate the extent of irradiation damage in the vessel materials and to determine the effect of annealing. The methods proposed for operational inspection of the vessel for irradiation damage and possible materials for future power producing high temperature gas cooled reactor pressure vessels are discussed. (auth)

40950 (DP-Report-103) THE CORROSION OF GRAPHITE IN DRAGON AND THE DEPLETION OF REACTANTS. Project DRAGON. Valette, L. (Atomic Energy Establishment, Winfrith (England)). Jun 1962. 31p. (CONF-620305-5; CONF-620407-4). Dep. CFSTI.

From Carbon Transfer Discussion Meeting, Dorchester, Dorset, England and Meeting of the Royal Institute of Engineers Nuclear Energy Section, The Hague, Netherlands.

The effects of depletion of carbon dioxide impurity in the helium coolant on the corrosion of graphite surfaces in the high temperature gas cooled reactor Dragon are discussed. The depletion depends on corrosion rate, the geometry of the system and the flow rate. Equations for various geometrical arrangements of the reacting graphite are established and calculations made for depletion rates in the purge and in the main flow of Dragon assuming graphite with a reactivity similar to that of Grade O. It is incorrect to assume that the corrosion would be spread uniformly over the ten fuel boxes contained in a fuel rod. In actual fact, the reaction may be confined to the first centimeter of the first fuel box, giving very deep corrosion and possibly penetration. Apart from this initial region, corrosion will be negligible due to the depletion of the oxidants. (auth)

40951 (DP-Report-183) A REVIEW OF THE ACTIVITIES OF THE DRAGON HEAT TRANSFER AND GAS DYNAMICS GROUP. Project DRAGON. Husain, L. A. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 24p. (CONF-630511-15). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

Techniques for the measurement of temperatures up to 2000°C, studies of the flow pattern through the reactor channels, basic heat transfer studies, the primary heat exchanger and a prototype regenerative freezer for the coolant clean-up plant are described. (57 references) (auth)

40952 (DP-Report-184) EXPERIMENTAL LOCAL HEAT TRANSFER AND FRICTION COEFFICIENTS FOR SUBSONIC LAMINAR, TRANSITIONAL, AND TURBULENT FLOW OF AIR OR HELIUM IN A TUBE AT HIGH TEMPERATURES. Project DRAGON. Dalle Donne, M.; Bowditch, F. H. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 79p. (CONF-630511-11). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

Experimental local heat transfer and friction coefficients are correlated for subsonic laminar, turbulent, and transitional flow of air or helium through a high temperature tube with long unheated entrance length. 11 references. (auth)

40953 (DP-Report-185) HIGH TEMPERATURE CONVECTIVE HEAT TRANSFER IN AN ANNULUS. Project DRAGON. Alami, R.; Butcher, A. A. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 46p. (CONF-630511-1). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

Overall and local heat transfer coefficients are derived for the heat transfer from the inner core of an annulus at high temperatures. At high temperatures, the effects of temperature and heat flux ratios on heat transfer coefficients and friction factors are of importance. The high core temperature tends to increase the thickness of the boundary layer, but this thickness is itself modified by the average velocity, its distribution, and also by the heat flux ratio. Experimental velocity and temperature distributions substantiate these temperature and heat flux effects, and these are interpreted by correction factors in the empirical formulae of heat transfer. (16 references) (auth)

40954 (DP-Report-186) THE EFFECT OF GEOMETRY ON CONVECTIVE HEAT TRANSFER IN THE DRAGON CHANNEL. Project DRAGON. Robinson, C. H.; Hansen, K. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 21p. (CONF-630511-23). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

Original design calculations on the heat transfer and fluid flow in the coolant channels of the Dragon core were based on correlations for a smooth cylinder allowing for both high surface temperature and length/diameter ratio. Experiments which were performed to check the validity of the concept and which also investigated the effects of modifications to the surfaces on the heat transfer and fluid flow properties are described. (7 references) (auth)

40955 (DP-Report-195) EXPERIMENTAL WORK CARRIED OUT ON DRAGON HEAT EXCHANGER TEST FLANGE ASSEMBLY. Project DRAGON. Woodley, H. J. (Atomic Energy Establishment, Winfrith (England)). Jun 1963. 42p. Dep. CFSTI.

In order to evaluate the effectiveness of the sealing system intended for use in the Dragon heat exchanger and pressure vessel sealing flanges, environmental tests were carried out on a flange representative of and with similar dimensions to the type intended for use on the heat exchangers. Tests were made over the temperature range 20 to 220°C and at pressures of up to 350 psig. Satisfactory seals were maintained under these conditions using sealing gaskets manufactured from silver, but satisfactory results were obtained at room temperature only when aluminum gaskets were used. (auth)

40956 (DP-Report-197) FLANGED JOINTS FOR DRAGON PRIMARY CIRCUIT. Preliminary Report. Project DRAGON. Simmons, W. E. (Atomic Energy Establishment, Winfrith (England)). Jun 1963. 24p. Dep. CFSTI.

The leak tightness requirements, the type of joints used, design aspects, and a summary of test results are presented. (auth)

40957 (DP-Report-204) PRECONCENTRATION OF IMPURITIES IN THE DRAGON PURGE FLOW BY THERMAL DIFFUSION. Project DRAGON. Los, J.; Velds, C. A.; Roemberg, E. (Atomic Energy Establishment, Winfrith (England)). Jul 1963. 22p. Dep. CFSTI.

The development of a concentrating device based on thermal diffusion for the Dragon HTGR is reviewed. Some of the problems encountered when using gas cooling for high temperature reactor systems are described. A description of the coolant purification process and purity control system reveals the necessity of preconcentration prior to gas analysis. The theoretical and experimental research effort applied to the development of a preconcentrator device based on thermal diffusion is summarized. (auth)

40958 (DP-Report-206) LEAKAGE AND STIFFNESS MEASUREMENTS MADE ON MANHOLE FLANGE AND COVER

TEST ASSEMBLY. Project DRAGON. Woodley, H. J. (Atomic Energy Establishment, Winfrith (England)). Aug 1963. 25p. Dep. CFSTI.

Tests were carried out on a specimen representative of the flange and manhole cover assembly located at the base of the Dragon Reactor pressure vessel. While subjected to the pressure loading conditions likely to be experienced during service, the required standard of leak tightness was maintained. In addition to leak tightness, flange rotation was measured. (auth)

40959 (DP-Report-236) BLOWERS AND VARIABLE FREQUENCY GENERATING SETS CONTROL CIRCUIT. Project DRAGON. Dondi, G.; Giordano, P. G. (Atomic Energy Establishment, Winfrith (England)). Jan 1964. 84p. Dep. CFSTI.

The control circuit and instrumentation for the six blowers in the primary gas coolant circuit of the Dragon Reactor and for the four variable frequency generating sets driving the circulators are described. (auth)

40960 (DP-Report-238) CONTROL CIRCUIT FOR THE BY-PASS VALVES IN THE PRIMARY GAS CIRCUIT. Project DRAGON. Caldarola, L.; Giordano, P. G. (Atomic Energy Establishment, Winfrith (England)). Nov 1963. 22p. Dep. CFSTI.

The primary helium coolant for the Dragon high temperature reactor is divided into six parallel streams, each stream having its own blower and heat exchanger. The gas flow is also controlled by six by-pass valves, one to each duct from the pressure vessel to the heat exchanger. The control circuitry and instrumentation for these by-pass valves are described. (auth)

40961 (DP-Report-239) PRIMARY GAS CIRCUIT INSTRUMENTATION. Project DRAGON. Giordano, P. G. (Atomic Energy Establishment, Winfrith (England)). Nov 1963. 31p. Dep. CFSTI.

The installed instrumentation for measuring temperature, pressure, and flow at various points in the primary coolant circuit is described. Instrumentation for the indication of blower speed and vibration, and by-pass valve position is also described. (auth)

40962 (DP-Report-241) ANALYSIS OF TRACE IMPURITIES IN HELIUM. Project DRAGON. Christensen, T. B.; Roemberg, E. (Atomic Energy Establishment, Winfrith (England)). Jan 1964. 65p. Dep. CFSTI.

An account of experimental work carried out to assess the katharometer as a continuous monitor of total impurities, the MS 10 mass spectrometer, the electrolytic hygrometer, and the influence of sampling pipes in the determination of small moisture concentrations is presented. The results are discussed with a view to their relevance for the analytical requirements of the Dragon Reactor. (auth)

40963 (DP-Report-248) THE LEAK TESTING OF THE HELIUM PURIFICATION PILOT PLANT. Project DRAGON. Milne, J. M. (Atomic Energy Establishment, Winfrith (England)). Dec 1963. 46p. Dep. CFSTI.

A description of the pressure strength and leak testing procedures is given for the Dragon helium purification pilot plant. Hydraulic or pneumatic tests were carried out on components, and low pressure helium leak tests followed on the assembled plant. High pressure helium leak tests were carried out at plant working pressures using a mass spectrometer. Results, a discussion, and conclusions of these tests are given. (6 references) (auth)

40964 (DP-Report-252) DETERMINATION OF PRIMARY CIRCUIT BEHAVIOUR IN THE DRAGON REACTOR BY THE USE OF A NOMOGRAM. Project DRAGON. Blake, J. P. H. (Atomic Energy Establishment, Winfrith (England)). Jan 1964. 33p. Dep. CFSTI.

A method of determining the condition of the primary circuit of Dragon in defined circumstances by the use of a multiple straight line nomogram is described. The method of construction of this type of nomogram is also given. (auth)

40965 (DP-Report-269) REACTOR TEST VESSEL AND TEST PROGRAMME. Project DRAGON. Pugh, J. (Atomic Energy Establishment, Winfrith (England)). Apr 1964. 30p. Dep. CFSTI.

A test vessel was built and a test programme arranged to study the problems that could arise on the design of the Dragon reactor pressure vessel upper dome and main flange. The programme of test work included an extensive strain gauge analysis of the pressure shell, a study of several flange configurations and the development of a procedure for the leak detection of reactor primary circuits by helium mass spectrometer. (12 references) (auth)

40966 (DP-Report-271) THE DRAGON HELIUM PURIFICATION PILOT PLANT. PART I. INVESTIGATION OF THE HELIUM PURIFICATION PROCESS TO BE USED IN THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Voice, E. H.; Wood, F. C. (Atomic Energy Establishment, Winfrith (England)). Jun 1964. 69p. Dep. CFSTI.

The helium purification process to be used for the fuel element purge in the DRAGON Reactor Experiment is investigated in a Pilot Plant operating at the correct helium flow rate and pressure. The efficiency of the purification process for removing the gaseous impurities and fission products which may be present in the helium of the Reactor Experiment is analyzed. (16 references) (auth)

40967 (DP-Report-272) THE DRAGON HELIUM PURIFICATION PILOT PLANT. PART II. THE ANALYTICAL INSTRUMENTATION. Project DRAGON. Voice, Eric H. (Atomic Energy Establishment, Winfrith (England)). May 1964. 65p. Dep. CFSTI.

The analytical instruments used on the Pilot Plant are described. The performance and limitations of the instruments during two years operation are examined in detail. Improvements are recommended. (41 references) (auth)

40968 (DP-Report-275) A SIMPLE VACUUM-INSULATED LINE AND ITS PERFORMANCE. Project DRAGON. Voice, Eric H. (Atomic Energy Establishment, Winfrith (England)). May 1964. 20p. Dep. CFSTI.

The construction of a vacuum-insulated metal pipeline is described and the performance derived from a simple experiment. The overall heat influx including end effects when carrying liquid nitrogen is 5 watts per metre for a length of 3 metres, or 0.8 watts per metre across the annulus only. (5 references) (auth)

40969 (DP-Report-277) ELECTRON BEAM SOLDERING EXPERIMENTS FOR BURSTING DISC ASSEMBLIES. Project DRAGON. Hansen, R. A. (Atomic Energy Establishment, Winfrith (England)). May 1964. 15p. Dep. CFSTI.

Special vacuum tight bursting disc assemblies are required for the Dragon helium purification plant. Experiments have been performed in order to find out whether it is possible to manufacture the assemblies by electron beam soldering the very thin discs to the body material. One method which is acceptable is described. (auth)

40970 (DP-Report-282) STUDY OF PERFORMANCE OF TERTIARY CIRCUIT CONTROL VALVE. Project DRAGON. Black, W. S. A.; Holzner, J. (Atomic Energy Establishment, Winfrith (England)). Sep 1964. 30p. Dep. CFSTI.

The function and design of the tertiary circuit control valve and control system are described and analysed. The effects of a reactor trip from 20 MW as a result of failure of electrical mains supply are discussed for the extremes of control valve positions possible. Rough calculations are presented to indicate that conditions in secondary, emergency and tertiary circuits will remain satisfactory. Settings for the forced draught air cooler are recommended for the full range of reactor thermal power. (auth)

40971 (DP-Report-298) STEAM LEAK DETECTION IN THE SECONDARY CIRCUIT OF THE DRAGON REACTOR. Project DRAGON. Davis, E. (Atomic Energy Establishment, Winfrith (England)). Oct 1964. 20p. Dep. CFSTI.

Methods are described for detecting and measuring moisture leaks from the Dragon secondary circuit. The development is outlined of equipment which can detect leaks of 1 to 3 g/h of water from the ring joint flanges in the circuit. (auth)

40972 (DP-Report-313) EXPERIMENTS ON GAS BEARINGS FOR THE DRAGON PRIMARY CIRCULATORS. Project DRAGON. A REPORT ON WORK DONE UNDER THE DIRECTION OF D. PANTALL. Robinson, Cyril H.; Elliot, D.; Wood, R. W.; Jones, T. S. (Atomic Energy Establishment, Winfrith (England)). Jan 1965. 45p. Dep. CFSTI.

The power requirements of the Dragon helium coolant circulator made shafts twice the diameter of any previously used on an industrial scale imperative and previous experience of operating in helium atmospheres was limited. The work described demonstrates the feasibility of running an assembly with characteristics similar to those of the Dragon primary circulator in pure helium at required pressure and temperatures. This successful operation can be achieved with the pocket type of bearings which are featured in the design selected by the contractor. The materials chosen for the circulator shaft and bearings cannot be expected to undergo stopping and starting reliably without using jacking gas. The test rig closely simulated the Brown–Boveri design for the primary circulator. Dynamic tests were performed to develop bearings capable of stable operation at speeds up to 12,000 r.p.m. Tests were made with oval bearings and pocket bearings, and on the use of jacking gas. (6 references) (auth)

40973 (DP-Report-330) AN ASSESSMENT OF THE CARBON TRANSPORT PROBLEM IN HIGH TEMPERATURE GAS

COOLED REACTORS. Project DRAGON. Pointud, M. L.; Roemberg, E. (Atomic Energy Establishment, Winfrith (England)). Jul 1965. 82p. Dep. CFSTI.

The carbon transport problem is analyzed by assessing the importance of the different parameters. Equations are presented which relate the maximum permissible corrosion to the attack of the fuel particle coating. Other expressions allow the estimation of purification flow or the maximum permissible water inleakage required to avoid excessive graphite corrosion and carbon deposition, as function of corrosion rates, heat exchanger reactivity, total flow, thermodynamic equilibria, etc. Some thoughts have also been extended to show how the concentrations of the reactants can vary as function of time when constant along the coolant circuit. (auth)

40974 (DP-Report-346) FURTHER ENVIRONMENTAL TESTS ON SOLENOID OPERATED VALVES FOR THE LEAK DETECTION AND GAS SAMPLING SYSTEMS. Project DRAGON. Woodley, H. (Atomic Energy Establishment, Winfrith (England)). May 1965. 9p. Dep. CFSTI.

Results indicate that the valves used in the leak detection system should give satisfactory service provided that the rubber components are changed yearly. Good results were not obtained from the offset valves intended for the gas sampling system. (auth)

40975 (NP-9830) THE DISTRIBUTION OF FISSION PRODUCTS IN THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Schmidt, H.; Fullom, S. W. H. (Atomic Energy Establishment, Winfrith (England)). Nov 1960. 16p. (DP-Report-9). Dep. CFSTI.

In a previous report an evaluation of the activities of various fission products was obtained assuming no hold up in the fuel particles or in the graphite walls. It was also assumed that all fission products had the same mobility. It is shown that this assumption can lead to an underestimate of the activities of daughter products in some cases and a new method is proposed which will always give an overestimate. (auth)

40976 MULTIREGION ANALYSIS FOR HEAT TRANSFER IN THE BOUNDARY REGION OF LIQUID METAL-COOLED FUEL ROD BUNDLES. Johannsen, K. (Technische Univ., Berlin); Ullrich, R.; Wolf, L. Atomwirt., Atomtech.; 15: 338-9(Jul 1970). (In German).

Fuel elements of liquid metal-cooled fast breeder reactors consist of several circular fuel rods surrounded by a hexagonal covering. For such an arrangement, a model is depicted and a second order partial differential equation that is linear and inhomogeneous is derived. Solution of the equation yields temperature distribution in the fuel cladding and cooling fluid. Results for uranium-plutonium reactors with sodium cooling are presented. 10 references. (H.B.G.)

Fuels

Refer also to abstracts 38708, 38746, 38747, 39105, and 39689.

40977 (DP-Report-64) PERMEABILITY AND PRESSURE TESTS ON THE DRAGON FUEL BOX. Project DRAGON. Beutler, H.; Mayerhofer, S.; Good, P. (Atomic Energy Establishment, Winfrith (England)). Nov 1961. 84p. Dep. CFSTI.

Methods for inspecting the Dragon fuel box and its components at various stages in its assembly are described. The properties which are investigated are the strength of the fuel box and its permeability coefficient. As a result of the experiments an inspection procedure is proposed. 5 references. (auth)

40978 (DP-Report-91) A PRELIMINARY ESTIMATE OF THE PHYSICAL CONSEQUENCES OF USING COATED PARTICLE FUEL INSERTS IN THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Husain, L. A. (Atomic Energy Establishment, Winfrith (England)). May 1962. 18p. Dep. CFSTI.

A solid cylindrical compact comprised of spherical metal particles of minimum radius 100 μ having a coating 100 μ thick and a packing fraction of .4 is suggested. A compact of fuel box O/D should accommodate the required nominal nuclear loading. For the most pessimistic case of particles impervious to heat the increase in fuel rod center temperature will be about 200°C and a maximum fuel temperature about 300°C above the present Dragon values. An attempt to assess the effect of coating conductivity suggests that the overall compact conductivity could be up to twice as good as that of the matrix. Thermal stresses in the pyrolytic coating may cause problems. 4 references. (auth)

40979 (DP-Report-105) FISSION PRODUCT TECHNOLOGY OF HIGH TEMPERATURE REACTORS. Project DRAGON. Glueckauf, E. (Atomic Energy Establishment, Harwell (England)). Aug. 1962. 22p. (CONF-620407-1). Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, England.

From Meeting of the Royal Institute of Engineers Nuclear Energy Section, The Hague, Netherlands.

The release of fission products from normal ceramic fuels and from coated, fission gas retaining fuels at temperatures up to 1500°C is discussed. It is noted that although the latter fuels show excellent retention of fission gases at 1500°C, a considerable proportion of long-lived metal fission products escaped by migration through the carbon coating by a mechanism different from that of the Xe-gas migration. (auth)

40980 (DP-Report-116) COATED PARTICLE FUEL FOR THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Huddle, R. A. U.; Gough, J. R.; Beutler, H. (Atomic Energy Establishment, Winfrith (England)). Oct 1962. 28p. Dep. CFSTI.

A brief description of the core of the Dragon Reactor is presented with emphasis on the major objectives concerning fuel element development. Reference is made to the proposed specification for the initial charge in describing the methods chosen for production of the coated particle fuel assemblies. An experimental fluidized bed employed for all coating studies is described and the development of the prototype production apparatus traced through its various stages. Methods used for making composite coatings of pyrolytic carbon-graphite and SiC are discussed and initial results of the evaluation studies are presented. (auth)

40981 (DP-Report-120) TESTING OF PYROLYTIC CARBON COATED FUEL PARTICLES DEVELOPMENT PROGRAMME. Project DRAGON. Nyboe, S.; Vivante, C. (Atomic Energy Establishment, Winfrith (England)). Nov 1962. 11p. Dep. CFSTI.

The various methods which are under consideration for the testing of pyrolytic-carbon-coated fission-product-retaining fuel particles are described. (auth)

40982 (DP-Report-136) POST-IRRADIATION RADIOCHEMICAL ANALYTICAL STUDIES ON DRAGON LOOPS AT A.E.R.E., HARWELL, DECEMBER 1962. Project DRAGON. Brown, P. E.; Flowers, R. H.; Lupton, D. F. M. (Atomic Energy Establishment, Winfrith (England)). Jan 1963. 9p. (CONF-630103-7; DW-(62)-35). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

Steady state release fractions for some Kr and Xe isotopes are given for each of four DIDO or PLUTO loop experiments. The fuel used was a cold-pressed mixture of graphite dust and finely powdered uranium; the current PLUTO loop charge (III) comprises carbon-coated UC_2 fuel particles. The most important conclusion is that there is a pronounced dependence of fractional release upon decay constant, the shorter lived gases being released to a smaller extent than longer lived isotopes of the same gas. (auth)

40983 (DP-Report-137) SOME MEASUREMENTS OF THE DIFFUSION OF ^{235}U FISSION PRODUCTS AND ^{233}Pa FROM COATED FUELS, DECEMBER 1962. Project DRAGON. Flowers, R. H.; Pattison, J.; Pummery, F. C. W.; Watts, R. (Atomic Energy Establishment, Winfrith (England)). Jan 1963. 27p. (CONF-630103-12; AERE-R-4215). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

The irradiation of coated uranium carbide fuels in the thermal neutron flux of DIDO or BEPO is described. Emergent fission products are analyzed spectrophotometrically. Pa-233 is found to be among the least mobile species in carbon coatings, which would however allow the majority of long-lived metals of groups II and III to escape during a fuel element lifetime. It is concluded that silicon carbide coated UC_2 offers much more resistance to metal diffusion under trace irradiation than does carbon coated UC_2. (auth)

40984 (DP-Report-141) THE DESIGN OF THE DRAGON FIRST CHARGE FUEL ELEMENTS. Project DRAGON. Smith, E. (Atomic Energy Establishment, Winfrith (England)). Jan 1963. 16p. (CONF-630103-24). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

The design is described and is found to be appropriate for fuel which is expected to release a significant portion of its fission products and also for the testing of fission product retaining fuels. The magnitudes of thermal and irradiation induced stresses and their effect on fuel element performance are evaluated. (auth)

40985 (DP-Report-142) TENTATIVE PROPOSALS FOR THE QUALITY CONTROL, INSPECTION, AND TESTING OF PRODUCTION FUEL ELEMENTS FOR THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Conde, J. F. G. (Atomic Energy Establishment, Winfrith (England)). Jan 1963. 22p. (CONF-630103-9). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

The type of control considered desirable and the stages at which the proposed control procedures should be applied are indicated.

Raw materials, manufactured components, and completed assemblies are considered. (auth)

40986 (DP-Report-144) PROGRESS REPORT ON H.T.G.C. PLUTO LOOP IRRADIATIONS II AND III. Project DRAGON. Lengweiler, H. (Atomic Energy Establishment, Winfrith (England); Sterry, F. (Atomic Energy Research Establishment, Harwell (England)). Jan 1963. 23p. (CONF-630103-18; DW-(62)-36). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

Details and results of the Charge II irradiation are given, the charge comprising enriched uranium powder compacted into rings with graphite powder, enclosed in a prototype fuel tube. The fuel temperature is 1000 to 1200°C. Details of krypton and xenon release are given: release of fission gases was always higher than in IA. Significant change in the rate of emission during the experiment is shown, and considerable amounts of short-lived gases were determined. The performance of the charcoal delay bed was affected by evolution of large amounts of CO, CO_2, H_2 from the specimen. (auth)

40987 (DP-Report-150) THE FUEL ELEMENT PROGRAMME. Project DRAGON. Huddle, R. A. U. (Atomic Energy Establishment, Winfrith (England)). Jan 1963. 14p. (CONF-630103-15). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

Development of the graphite for the fuel tube and of both fission product emitting and fission product retaining fuels is outlined. (auth)

40988 (DP-Report-180) THORIUM RESONANCE ABSORPTION IN THE FUEL ELEMENTS OF THE DRAGON REACTOR EXPERIMENTS. Project DRAGON. Schroeder, E. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 22p. (CONF-630511-26). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

The resonance absorption for the Dragon fuel element was calculated by a Monte Carlo method and a conventional analytical method. The results of both treatments are in good agreement. For higher absorber concentrations the Monte Carlo method yields relative higher resonance integrals. This is assigned to the deviation from the flat source assumption made for the analytical solution. 16 references. (auth)

40989 (DP-Report-192) COMPARATIVE EVALUATION OF TEMPERATURE DISTRIBUTIONS IN THE DRAGON FUEL RODS, INSERTS, AND CARTRIDGES. Project DRAGON. Alami, R. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 23p. (CONF-630511-2). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

Some of the calculations carried out for comparison of temperature distributions in various types of fuel rods are presented. A graphical method of optimization of fuel cartridge variables is also presented, stressing the essential factors to be taken into account in order to achieve acceptable maximum fuel temperatures. (auth)

40990 (DP-Report-199) PRESSURE DROP CHARACTERISTICS OF THE SEVEN ELEMENT RIG. Project DRAGON. Alami, R. (Atomic Energy Establishment, Winfrith (England)). Jul 1963. 23p. Dep. CFSTI.

The calculations related to the pressure drop characteristics of the Seven Element Rig with helium flows 1 to 4 lb/s and temperatures of 100 to 900°C are presented. (auth)

40991 (DP-Report-212) PRODUCTION SCALE DEVELOPMENT OF FUEL CARTRIDGE CONSOLIDATION. Project DRAGON. Redding, G. B. (Atomic Energy Establishment, Winfrith (England)). Sep 1963. 20p. Dep. CFSTI.

Following initial development of the method of powder casting for the incorporation of coated particle fuel in a substantially graphitic matrix, the process was developed up to the production stage. The preparation of matrix material for the production of fuel inserts (or cartridges) for the first charge of the Dragon Reactor Experiment, the techniques of mixing and warm pressing, and exploratory experiments on the effects of these processes on the integrity of the coated particles are described. Dimensional variations as a result of further processing were determined, and some values of thermal expansion are presented. (auth)

40992 (DP-Report-214(Pt.1)) PREPARATION AND EVALUATION OF FISSION PRODUCT RETAINING FUEL FOR THE IIIA CHARGE OF THE PLUTO LOOP. PART I. PREPARATION OF FUEL. Project DRAGON. Gough, J. R. C.; Burnett, R. C.; Beutler, H.; Redding, G. B. (Atomic Energy Establishment, Winfrith (England)). Sep 1963. 19p. Dep. CFSTI.

The preparation of enriched uranium dicarbide particles coated with pyrolytic carbon and consolidated into fuel elements is described. (auth)

40993 (DP-Report-233) BEHAVIOUR OF COATED PARTICLES SUBJECTED TO ACID LEACHING AND THERMAL SHOCK TESTS. Project DRAGON. Good, P. D.; Pointud, R. (Atomic Energy Establishment, Winfrith (England)). Oct 1963. 21p. Dep. CFSTI.

Nitric acid leaching of pyrocarbon coated Dragon fuel particles failed to remove permanently uranium or thorium contamination from the surface of the particles and attacked the pyrocarbon, enhancing any weaknesses or defects present in the coating. Limited thermal shock treatment of the coated particles did not appear to introduce serious deterioration. (auth)

40994 (DP-Report-262) STUDIES ON THE COATING OF FUEL PARTICLES FOR THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Kern, D.; Gough, J. R. C.; Beutler, H. (Atomic Energy Establishment, Winfrith (England)). Feb 1964. 34p. Dep. CFSTI.

The conditions required to produce pyrolytic carbon coatings of various structures and dense silicon carbide coatings are investigated. Variations of weight increase, carbon efficiency, and deposition rate with the coating parameters (temperature of deposition, weight and density of charge, concentration of costing agent and time of coating) are studied in detail. The use of nitrogen as carrier gas in lieu of argon is shown to be feasible after the initial layer of pyrolytic carbon is applied. The extent of deposition of pyrolytic carbon into the pores of sintered particles is determined and the available evidence on surface contamination, the hydrolysis of coated particles containing thorium carbide, and the mechanism of spearhead attack is assessed. 9 references. (auth)

40995 (DP-Report-263) DEVELOPMENT OF FUEL ELEMENT ASSEMBLY TECHNIQUES FOR THE FIRST CHARGE OF THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Burnett, R. C.; Gough, J. R. C.; Sinden, R. P. (Atomic Energy Establishment, Winfrith (England)). Feb 1964. 44p. Dep. CFSTI.

The principal features of fuel element design for the first charge of the reactor experiment are described. The somewhat complicated design requires considerable development of assembly techniques. The assembly techniques are described. 7 references. (auth)

40996 (DP-Report-265) PLUTONIUM FUEL CYCLES IN HIGH-TEMPERATURE GAS COOLED REACTORS. Project DRAGON. Gratton, C. P. (Atomic Energy Establishment, Winfrith (England)). Oct 1960. 58p. Dep. CFSTI.

The performances of various fuel cycles using plutonium in high-temperature gas-cooled reactors are compared. Fuel costs for the various fuel cycles are analyzed. (auth)

40997 (DP-Report-288) DETECTION AND LOCATION OF FAULTY FUEL ELEMENTS IN THE DRAGON REACTOR. Project DRAGON. Acciarri, P.; Mitchell, E. J. (Atomic Energy Establishment, Winfrith (England)). Aug 1964. 51p. Dep. CFSTI.

In order to detect and locate faulty fuel elements in the Dragon Reactor, facilities for monitoring the primary coolant and the fuel element purge flow are provided. These facilities and their method of operation are described. Approximate calculations, assuming a particular fuel arrangement, are presented to illustrate differences in activity and pressure measurements between the normal and various faulty fuel element conditions. (auth)

40998 (DP-Report-327) THE QUALITY CONTROL, INSPECTION, AND TESTING OF FUEL MATERIALS FOR THE FIRST CHARGE OF THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Conde, J. F. G.; Pointud, R.; Holliday, J.; Good, P. D.; Milne, J. M.; Smith, D. L. G.; Bird, E. J.; Siddall, R. E. (Atomic Energy Establishment, Winfrith (England)). Jul 1965. 86p. Dep. CFSTI.

The methods employed for the quality control, inspection and testing of the zirconium/uranium and thorium/uranium coated particle fuel materials and consolidated fuel cartridges for first fuel charge are described together with an indication of the general philosophy on which the programme of evaluation is based. It is concluded that the methods which were selected have proved practical and in general well suited to the declared objectives. A final conclusion on the relative importance of particular procedures of evaluation cannot be reached until the irradiation behavior of the fuel materials is established and the definitive parameters are clear. (20 references) (auth)

40999 (DP-Report-328) A SUMMARY OF THE RESULTS OBTAINED IN QUALITY CONTROL, INSPECTION, AND TESTING OF FUEL MATERIALS FOR THE FIRST CHARGE OF THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Conde, J. F. G.; Pointud, R. G.; Holliday, J.; Good, P. D.; Milne,

J. M. (Atomic Energy Establishment, Winfrith (England)). Oct 1965. 150p. Dep. CFSTI.

The results obtained in the quality control, inspection and testing of the zirconium–uranium and thorium–uranium carbide coated particle fuels and consolidated fuel cartridges for the first charge of the Dragon Reactor are summarized and discussed. (auth)

41000 (DP-Report-333) EXPERIMENTS ON THE HEAT TREATMENT OF FUEL KERNELS PREPARED BY THE SOL–GEL PROCESS. Project DRAGON. Hankart, L. J. (Atomic Energy Establishment, Winfrith (England)). Apr 1965. 28p. Dep. CFSTI.

The influence of various heat treatments on the properties of ThC_2-UC_2 fuel kernels prepared by a number of Sol–Gel processes is investigated. It is shown that the density of the fired product depends both on the method of manufacture of the green kernels and their subsequent heat treatment. (auth)

41001 (DP-Report-334) TESTING AND EVALUATION OF REACTOR FUEL PARTICLES. Project DRAGON. Koss, P.; Bildstein, H. (Atomic Energy Establishment, Winfrith (England)). Apr 1965. 46p. Dep. CFSTI.

The results of Xe release measurements performed on a series of experimental as well as on Dragon production samples are reported. Reactivation analysis of Studsvik and full size Dragon fuel compacts is in progress and the methods used are described. It is shown that a close dependence of Xe release on surface contamination of coated particles exists. Measurements of the amount of fission products leaving the coated particles by recoil during irradiation show that R/B values of particles with high α-count rates are of the order of 10^{-4}. The results of disintegration experiments performed on irradiated Pluto 3 A, Pluto 4 A and Diorit compacts are given. Chlorination proved very successful in the detection of defective particles. (6 references) (auth)

41002 (DP-Report-337) DRAGON–DIORIT IRRADIATION EXPERIMENT. REPORT ON THE SECOND AND THIRD IRRADIATION CHARGE. Project DRAGON. Schaub, Th.; Dorra, L. (Eidgenoessisches Institut fuer Reaktorforschung, Wurenlingen (Switzerland)). Apr 1965. 89p. Dep. CFSTI.

The characteristics and the behavior of the second and the third charge of different Dragon fuels irradiated in a vertical irradiation facility of the DIORIT reactor during May 1963 until January 1964 are described. The experienced difficulties are discussed in detail. (6 references) (auth)

41003 (DP-Report-341) POST-IRRADIATION RADIOCHEMICAL ANALYSIS OF CHARGES V AND VI OF PLUTO LOOP A. Project DRAGON. Brown, P. E.; de Nordwall, H. J.; Dosudil, I. (Atomic Energy Research Establishment, Harwell (England)). May 1965. 61p. (AERE-R-4856). Dep. CFSTI.

The fifth and sixth charges of Pluto loop A were essentially similar. The fuel particles were either uncoated or coated lightly enough to ensure failure under operating conditions. They were contained in a graphite matrix. The distribution of the principal fission products between the purge circuit, the primary coolant circuit and the graphite components is described in detail. (9 references) (auth)

41004 (DP-Report-342) FUEL ELEMENTS FOR THE FIRST CORE LOADING OF THE DRAGON REACTOR. Project DRAGON. Smith, E. (Atomic Energy Establishment, Winfrith (England)). Jul 1965. 56p. Dep. CFSTI.

The final design of fuel element for first core loading in the Dragon Reactor is described and its operational characteristics are discussed. The expected temperature distribution in the fuel rod assemblies is presented graphically and thermal strains are evaluated. The effects of irradiation induced dimensional changes are considered and it is shown that in the absence of creep this is the most important structural and material factor in limiting the life of an element in the core. It is further shown that irradiation induced creep can significantly alter the distribution of such strains in a fuel tube in a very short time, and that complete relaxation of thermal strains may occur. If creep occurs then the maximum stress evaluated from existing data, which will occur in a cold tube with the reactor shutdown, is shown to be safe if a maximum surface temperature of 1030°C is not exceeded during operation at full power. (5 references) (auth)

41005 (DP-Report-345) FABRICATION OF SPHERICAL CARBIDE PARTICLES. Project DRAGON. Huet, J. J.; Van Geel, J. (Atomic Energy Establishment, Winfrith (England)). May 1965. 26p. Dep. CFSTI.

The heat treatment of pyrolytic carbon coated ThC_2-UC_2 "Sol-Gel" particles is studied. Experiments show that as the temperature of this material is slowly raised, five distinct pressure peaks are discerned. These occur at about 200, 400, 1050, 1500 and 1800°C. In spite of these pressure surges, Sol-Gel particles are converted to carbide and retain their shape although the shrinkage accompanying conversion is very large (~40% reduction in diameter). (auth)

41006 (DP-Report-348) THE DEVELOPMENT OF HX30 GRAPHITE. Project DRAGON. Longstaff, B.; Jenkins, T. R.; Morris, J. B.; Graham, L. W. (Atomic Energy Research Establishment, Harwell (England)). Jun 1965. 71p. (AERE-R-4938). Dep. CFSTI.

The specification of a graphite suitable for making DRAGON fuel tubes which operate on the back-sweep purge principle includes the two requirements: the viscous permeability constant must be less than 3×10^{-11} cm^2, and the fission gas transmission coefficient must be less than 10^{-6} cm^2/sec. at 20 atm., 750°C., and 2 p.s.i. pressure drop. In order to meet these requirements, the pore structure of the material should consist of a small number of large pores rather than the converse. Many commercially available fine-grain graphites were examined, but none met the specification because their major pore size of around 4 micron or less was too small. (14 references)(auth)

41007 (DP-Report-354) A COMPARATIVE STUDY OF SEMI-CONDUCTOR GAMMA SPECTROMETERS FOR SCANNING OF IRRADIATED DRAGON FUEL ELEMENTS. Project DRAGON. Hick, H. (Atomic Energy Establishment, Winfrith (England)). Jun 1965. 41p. Dep. CFSTI.

The use of a semiconductor detector is considered for gamma spectroscopic examination of irradiated Dragon fuel rods in order to achieve higher energy resolution. To facilitate the choice of the most suitable instrument from several spectrometer types (all using a semiconductor detector), a photopeak spectrometer, an anti-Compton spectrometer and a Compton spectrometer are compared. The geometric configurations of all three spectrometer types are chosen for approximately optimal performances and fit into the proposed arrangement. It proved reasonable to use the same semiconductor detector and the same primary beam geometry in all three spectrometer types, thus allowing easier comparison. (9 references) (auth)

41008 (DP-Report-416) FISSION PRODUCT RETENTION IN H.T.R. FUEL ELEMENTS. Project DRAGON. de Nordwall, H. J.; Brown, P. E.; Pattison, J. (Atomic Energy Research Establishment, Harwell (England)). Feb 1966. 15p. (AERE-M-1723). Dep. CFSTI.

An attempt to apply the equations describing heat flow through a slab into a region at zero temperature to measurements of radial fission product concentration profiles and coolant circuit activity from Pluto Loop A experiments is described. The retention of fission products in the structural components of Pluto Loop A Fuel Elements is examined. The fission product retention in the fuel tubes and fuel free zones is compared with that in the fuel particles. For Sr and Ba in particular the retention was good in the times involved. The problem of whether this retention will last the lifetime of a fuel element, and under what conditions the fuel tube remains useful as a method of fission product retention is discussed. The need for a model of the fission product transport, so that extrapolation to longer times is possible, is examined. 12 references. (auth)

41009 (TRG-Report-1911, pp 26-35) IRRADIATION PROGRAM FOR THE PHENIX FUEL ELEMENT. Ratier, J. L. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires); Andre, J. P.; Weisz, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

The philosophy behind the irradiation program is discussed. Main characteristics related to fuel pins under test in Rapsodie and DFR are compared. An outline is given of the programs for examining the effect of irradiation on creep and ductility of stainless steel canning material. (UK)

41010 (TRG-Report-1911, pp 44-58) FAST FLUX IRRADIATION PROGRAM IN JAPAN. Uematsu, Kunihiko; Kashihara, Hidechiyo; Kubota, Tadashi; Ohno, Tadao (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)).

The irradiation programme is designed to provide information on the performance of the fuel elements to be used in the initial core of Japan's Experimental Fast Reactor. The design parameters and development schedule of the reactor are presented. The programme for 1968 to 71, which depends upon facilities in DFR, Rapsodie, Enrico Fermi, and GETR's thermal neutron flux filter, is discussed in detail. (UK)

41011 (TRG-Report-1911, pp 59-73) THE U. S. PROGRAM FOR DEVELOPING LMFBR FUEL ELEMENTS. Venard, J. T.; Kelman, L. R. (Argonne National Lab., Ill.).

The background and objectives in the development of liquid metal

fast breeder reactors are discussed, with a brief reference to economic factors. The program consists of three stages: the Fast Flux Test Facility; demonstration reactors; and commercial reactors. Efforts are concentrated on a fuel element of PuO_2-UO_2 in stainless steel canning and the role of the FFTR in the development of the fuel element is discussed in some detail. 16 references. (UK)

41012 (TRG-Report-1911, pp 74-81) SOME ASPECTS OF THE BEHAVIOUR OF FUEL, CLADDING, AND STRUCTURAL MATERIALS UNDER FAST REACTOR CONDITIONS AND THE FUEL ELEMENT TEST PROGRAMME IN THE BOR-60 REACTOR. Prokhorov, V. I.; Lebedev, I. G.; Krasnoyarov, N. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, [Moscow]).

The differences observed, or to be expected, in the behaviour of fuels and cladding materials, as a result of differences in test conditions, are examined. It is shown that tests in thermal reactors are inadequate for determining the effect of fast reactor conditions. Results are presented of mechanical property studies on stainless steel cladding materials irradiated in SM-2. The program for testing fuel, cladding and fuel elements in the BOR-60 experimental fast reactor is briefly indicated. 6 references. (UK)

41013 (TRG-Report-1911, pp 82-100) BASIS, STATUS, AND PROGRAM OF GERMAN FAST BREEDER PIN DEVELOPMENT. Karsten, G.; Gerken, A.; Closs, K. D.; Laue, H. J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik).

Concepts of fast breeder fuel elements and the schemes adopted for both fuel element development and post-irradiation examination are listed. Irradiation experiments on oxide fuels are described and the application of computer analysis to pin design is explained. Details are given of the present status of parameter and proof tests, irradiation of cladding materials, and of the future programme for oxide and carbide fuels. 5 references. (UK)

41014 (TRG-Report-1911, pp 101-15) IRRADIATIONS FOR FAST REACTOR FUEL DEVELOPMENT. THE PROGRAM OF THE EUROPEAN INSTITUTE FOR TRANSURANIUM ELEMENTS. Gabolde, Jean (European Atomic Energy Community, Karlsruhe (West Germany). European Transuranium Inst.).

Aims of an irradiation program are specified and it is shown how efficiency is increased by a proper feedback of all information from one experiment to the next stage of the programme. The principal stages of a well-planned program, using both thermal and fast irradiations, are outlined. The present status of the programme on Pu fuels is briefly summarized. Work on oxide fuels is the most advanced, the parameters under investigation being stoichiometry and radial fuel rearrangement. (UK)

41015 (TRG-Report-1911, pp 266-86) TARGET '79. Evans, E. A.; Hanson, J. E.; Shober, F. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The fuels development target for 1979 is a reliable fuel-cladding system which permits safe, economical, power generation by commercial fast breeder reactors. Recent developments and trends are explored, with emphasis on mixed oxide fuels and the role of the Fast Flux Test Facility. 37 references. (UK)

41016 WORK ON FURTHER DEVELOPMENT OF STEAM-COOLED FAST BREEDER REACTORS. Erbacher, F.; Malang, S.; Rust, K. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 15: 331-4(Jul 1970). (In German).

Progress at the institute for reactor components of the nuclear research center Karlsruhe is described with respect to steam-cooled fast breeder reactors. Research and development were devoted particularly to increasing reliability and power density of fuel elements. Three essential procedures were studied and improved; external spiraling cooling ribs, pressure equalization system to prevent bending or bursting of fuel elements, and internal ribs for heat conduction. Advantages of the new core design in comparison with previous concepts are compiled. (H.B.G.)

41017 FAST REACTOR FUEL PERFORMANCE MODEL DEVELOPMENT. Boltax, A.; Murray, P.; Biancheria, A. (Westinghouse Advanced Reactors Div., Madison, Pa.). Nucl. Appl. Technol.; 9: 326-37(Sep 1970).

The status of fast reactor mixed oxide fuel performance model development, involving the OLYMPUS and CYGRO-F codes, is reviewed. Input information in several critical areas is examined including: the swelling, irradiation creep, and ductility of stainless steel cladding; and the swelling and plasticity of mixed oxide fuel. The predictions from the two codes are illustrated by parametric studies and application to high fluence/burnup ratio fuel rods of interest to the LMFBR Program. The analytical studies indicate the major effects of stainless steel swelling on fuel rod performance and the relationship between fuel density and cladding creep strain. 14 references. (auth)

Auxiliary and Emergency Systems

41018 (APDA-255) CRITERIA FOR DETECTION OF SMALL SODIUM-WATER REACTIONS IN LMFBR STEAM GENERATORS. Ford, J. A.; Chamberlain, H. V.; Coleman, J. H.; Lindsey, P. S. (Atomic Power Development Associates, Inc., Detroit, Mich.). Jun 1970. Contract AT(11-1)-865. 119p. Dep. CFSTI.

An evaluation of various candidate instruments for the detection of small leaks was conducted for the purpose of developing leak detection systems for sodium-heated steam generators. Criteria developed require detection of a leak in sufficient time to allow for shutdown of the steam generator before significant repairs are necessary; or, alternatively, to require shutdown before secondary tube failures have occurred. Evaluation of preliminary data obtained during material wastage tests in a large sodium-water reaction test facility was made to determine the disposition of reaction products formed during the reaction. The major elements and input required for the analysis of leak detection are described and, for illustrative purposes, an analysis of a reference secondary system for a 1000-MW(e) LMFBR plant is presented. Although the analysis applies only to the system described, it illustrates the method needed for performing such an analysis. Evaluation of the candidate instruments for the particular system analyzed revealed that the most promising detectors are the electro-chemical oxygen meter and the APDA hydrogen meter; however, these cannot prevent damage under all circumstances. The acoustic detector has undergone a minimum amount of development; however, limited experimental data indicate that it has the greatest potential for fulfilling the criteria for leak detection. 27 references. (auth)

41019 (DP-Report-104) COOLANT PROCESSING IN THE DRAGON PROJECT. Project DRAGON. Wood, F. C. (Atomic Energy Establishment, Winfrith (England)). Jul 1962. 25p. (CONF-620407-2). Dep. CFSTI.

From Meeting of the Royal Institute of Engineers Nuclear Energy Section, The Hague, Netherlands.

The requirements of the helium purification plant are considered, assuming 100% release of fission Xe and Kr. The basis of the purification process is a purge system in which a small proportion of the primary coolant is withdrawn through purge channels in each of the 259 fuel rods, cooled, then purified externally to the main pressure vessel before being returned to the primary circuit. The reactor purification system and the pilot plant are detailed. A brief description of helium purification units used with experimental rigs and a short discussion of helium processing in the Peach Bottom prototype H.T.G.C. reactor in the U. S. are included. (auth)

41020 (DP-Report-193) DESORPTION OF WATER BY CHARCOAL. Project DRAGON. Tjerkstra, H.; Werner, L. (Atomic Energy Establishment, Winfrith (England)). Jun 1963. 27p. Dep. CFSTI.

Regeneration facilities for the charcoal in the main fission product delay units have to be provided because of the possibility that the water content might rise above an acceptable level and thereby shorten the delay time of the fission gases xenon and krypton. Therefore, the influence of different parameters on the desorption of water from charcoal was investigated. As a result the regeneration time for the Dragon delay units can be calculated. (auth)

41021 (DP-Report-207(Pt.1)) RADIOCHEMICAL ANALYSIS OF FISSION PRODUCTS IN THE DRAGON REACTOR. PART I. DESIGN AND OPERATION OF THE SYSTEM. Project DRAGON. Acciarri, P.; Mitchell, E. J. (Atomic Energy Establishment, Winfrith (England)). Aug 1963. 59p. Dep. CFSTI.

The methods and equipment chosen for the measurement of activities in the Dragon reactor fuel element purge gas flow and primary coolant circuit are described for both fission product retaining and fission product emitting fuels. The system enables the following operations to be carried out for any of the 37 individual fuel element assemblies: selective sampling of the purge flow: dilution of the purge flow: total activity measurement: gamma spectrometry: separation of Kr and Xe and independent gamma spectrometry: gamma spectrometry of the solid daughter products of Kr and Xe. In addition it is possible to measure the activity in the reactor primary coolant. Calculations are presented which indicate the probable order of the levels of activity for both coated and uncoated fuel. (auth)

41022 (DP-Report-245) TESTS ON STAGE II OF THE 37-WAY SELECTOR VALVE PROTOTYPE. Project DRAGON. Woodley, H. J. (Atomic Energy Establishment, Winfrith (England)). Jan 1964. 41p. Dep. CFSTI.

The results of the various tests which have been performed on the Stage II Prototype of the 37-way selector valve are presented. The Stage II Prototype is a full scale test model of the valve unit

which will be installed in the reactor system and was built to assess the degree of reliability and performance which might be expected from the final unit. (auth)

41023 (DP-Report-314) THE EMERGENCY CIRCUIT OF THE HEAT DISPOSAL SYSTEM. Project DRAGON. Black, W. S. A.; Holzner, J. (Atomic Energy Establishment, Winfrith (England)). Jan 1965. 33p. Dep. CFSTI.

Information on the function, design and operation of the emergency circuit is recorded for future inclusion in the plant record of the reactor experiment. All design and operating requirements are fully discussed and details of design calculation techniques are given in the Appendices. (17 references) (auth)

41024 (NYO-3906-11) ULTRASONIC THERMOMETRY IN LMFBR SYSTEMS. Progress Report Covering the Quarter Ending June 30, 1970. Papadakis, E. P.; Patch, D. R.; Lynnworth, L. C.; Carnevale, E. H. (Panametrics, Inc., Waltham, Mass.). Contract AT(30-1)-3906. 12p. Dep. CFSTI.

Several models of the ORTC-4 composite sensor were tested in a furnace and a modification of the design were decided upon. The FFTF centerline sensor simulation design was finalized, and the parts procured or ordered. The electromagnetic connector-transducer for manipulation under liquid sodium was built and tested at room temperature. The method for heating and simulated sensor was decided, and work on the heating apparatus is progressing. Part of this work continues to be the installation of the tungsten tube furnace. (auth)

41025 STANDBY POWER SUPPLIES FOR NUCLEAR GENERATING STATIONS. Allen, Russell E. (United Engineers and Constructors Inc., Philadelphia). IEEE (Inst. Elec. Electron. Eng.). Trans. Nucl. Sci.; NS-17: No. 1, 608-15(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Selection of diesel generators for use as standby power supplies for nuclear generating stations utilizing light water reactors has become an uncertain and time consuming process. Better understanding of the requirements and problems involved will lead to the development of a selection process in which there is confidence and with which delays will be reduced. Requirements discussed are those established by regulatory bodies, nuclear power plant standards and plant safety analyses. Problem areas investigated are load determination, rating selection and other considerations, such as control, modes of operation and auxiliary systems. Once requirements are evaluated and problems are identified, the selection process for standby power supplies can become an organized and knowledgeable effort, free from delays and uncertainty. 3 references. (auth)

Operation and Economics

41026 (DP-Report-173) BURN-UP ASSESSMENTS FOR A LAND BASED POWER REACTOR. Project DRAGON. Beliaev, G.; Brumeder, H. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 20p. (CONF-630511-3). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

In order to incorporate fuel elements which were realistic simulations of a high-temperature power reactor fuel element into the first charge of the Dragon Reactor Experiment, the performance of a 1000 MW(t) power reactor as a function of power density, fuel loading and thorium to uranium ratio was studied. Batch loadings only were considered. The application of FEVER, an IBM 7090 code written by General Atomic, to the assessment is described, and the cases which were treated are shown with selected results. The relationships between selected results and N-values for different initial ^{235}U loadings and core power densities are shown graphically. (auth)

41027 (DP-Report-203) MAFIA: A ONE-DIMENSIONAL BURN-UP CODE. Project DRAGON. Massimo, L.; Schloesser, J. (Atomic Energy Establishment, Winfrith (England)). Jul 1963. 33p. Dep. CFSTI.

The MAFIA programme is a one-dimensional burn-up code for high-temperature graphite-moderated reactors with provision for treating spectrum changes with time. It combines the General Atomic burn-up code FEVER with the Dragon Project multigroup diffusion code MUPO. (auth)

41028 (DP-Report-309) HELIOS, A ZERO-DIMENSIONAL MULTI-GROUP BURN-UP PROGRAMME. Project DRAGON. Schloesser, J. (Atomic Energy Establishment, Winfrith (England)). Jan 1965. 46p. Dep. CFSTI.

A description is given for an IBM-7090 program for calculating the burnup in graphite moderated reactors. It is specially suited for survey calculations and fuel cycle optimization. (auth)

41029 (DP-Report-409) DRAGON OPERATIONS SECOND QUARTERLY PROGRESS REPORT, SEPTEMBER TO NOVEMBER 1965. Project DRAGON. Barclay, F. J. (Atomic Energy Establishment, Winfrith (England)). Feb 1966. 28p. Dep. CFSTI.

The initial stages of the approach to power are discussed. The integrated power reached 500 MWD and a power level of 10 MW was sustained in steady operation. The operation and maintenance of items of reactor and chemical plant equipment are dealt with and details of core and primary circuit performance are given. Unscheduled shutdowns and unusual occurrences are summarized and the future program of operation is outlined. (auth)

41030 (EUR-4328) HIGH POWER DENSITY: HIGH TEMPERATURE REACTOR (HPD: HTR). Valette, L.; Schulten, R.; Markowski, B.; Foerster, S. (Kernforschungsanlage, Juelich (West Germany)). 29 Jul 1969. 26p. Dep. CFSTI (U. S. Sales Only).

An assessment of the effect of increasing simultaneously the power density of the core of an HTGR and the pressure of the primary coolant circuit is made. It is shown that by increasing the power density up to 12 MW/m^3 and the helium pressure to 80 atm, the fuel cycle cost would not be increased and the capital cost of a 600 MW(e) plant might be decreased by 5%. The pumping power would be smaller and thus the efficiency increased. The fuel temperature would not exceed 1400°C and the fast neutron dose in fuel and graphite would be slightly increased. It is recommended, on the basis of the preliminary study, to perform more detailed cost analysis of systems with increased power density. (auth)

41031 (PEL-197) PELINOMIC: A COMPUTER PROGRAMME FOR CALCULATING NUCLEAR POWER COSTS. Maunders, E. J. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Mar 1970. 8p. Dep. CFSTI (U. S. Sales Only).

PELINOMIC is a computer programme specifically designed for rapid comparisons of the costs of nuclear and fossil derived power, or for the evaluation of each in isolation. The nuclear fuel cycle cost consists of two components: the value of the first core loading for the reactor, plus the discounted value of the year to year fuel requirements as calculated by the "extended equilibrium" core model. Fossil fuel costs are assumed to be simply directly proportional to the energy produced. As written, the model is intended to be applied to non-breeding systems, but with simple adjustments to the cost data, the performance of breeding systems can be evaluated. The computer language used is Fortran. (auth)

41032 (TRG-Report-1911, pp 160-74) EXPERIENCE AND DEVELOPMENTS OF IRRADIATION TECHNIQUES USING THE DOUNREAY FAST REACTOR. Barclay, F. J.; Kirk, J. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group).

Current use of the DFR is discussed together with illustrations and a description of reactor design features and performance data. Case histories are given of the conception, irradiation, and post-irradiation examination of uninstrumented and instrumented irradiation vehicles. The two-region core arrangement and the greater use of modified driver fuel elements with increased loading of ^{235}U is described. Speculative fuel designs may be tested in 'fail-safe' vehicles irradiated at the core perimeter in carriers which may be unloaded if failure should cause the vehicle to stick. The irradiation of sub-assemblies of pins resembling PFR fuel and the proposed use of minisub-assemblies are described. (UK)

41033 (TRG-Report-1911, pp 220-34) IRRADIATIONS WORK AT EBR-II. Shewmon, Paul G. (Argonne National Lab., Ill.).

The performance of the Mark 1A element of U-5 w/o fissium Na bonded to 304L stainless steel is described. Details of experiments in progress to determine fuel behaviour at higher burn-ups are presented. The Mark II elements designed for this purpose are described. Fission product monitoring systems are also described. Brief accounts of the leaks encountered during operation and of future methods of leak determination are presented. Irradiation experiments for unencapsulated elements and the use of instrumented subassemblies are discussed. Observations are made on swelling of the cladding. The role of the Fuel Cycle facility is explained. (UK)

41034 (TRG-Report-1911, pp 235-49) THE SAFETY OF D.F.R. IRRADIATION EXPERIMENTS. Fordham, R. F. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch); Sussock, H. C.; Sutton, E. A. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group).

The failure of an irradiation experiment within D.F.R. might lead to the delay of the experimental programme. This problem is controlled by advice from a panel of safety assessors who require the designers of irradiation experiments to consider

the ways in which their experiments might fail and also to describe the consequences of the less improbable failures. A large number of factors may be involved in the assessment, embracing metallurgy, chemistry, engineering and applied physics. (auth) (UK)

Safety and Siting

Refer also to abstract 39092.

41035 (CONF-700608-5) DROP SIZE DISTRIBUTION AND SPRAY EFFECTIVENESS. Pasedag, W. F.; Gallagher, J. L. (Westinghouse Electric Corp., Pittsburgh, Pa.). [1969]. 23p. From American Nuclear Society Meeting, Los Angeles, Calif.

One of the most important parameters in a dropwise absorption process, such as the removal of iodine vapor from the post-accident reactor containment by sprays, is the drop size. Since a spectrum of drop sizes is produced by spray nozzles, rather than a single size, the size parameter has to be represented either by some appropriate mean diameter, or by a description of the entire drop size distribution. In single drop calculations of the iodine removal capability of the containment spray system, the Sauter (surface per unit volume) mean has generally been used to represent the drop size parameter. However, the selection of this representative diameter must be governed by the mass transfer mechanism involved, and would be different for the absorption of methyl iodide, or other fission products. In addition, changes in the drop size distribution due to condensation and coalescence are impossible to represent with this single parameter. For these reasons the spray effectiveness calculation performed should include consideration of the entire drop size spectrum. (auth)

41036 (DP-Report-283) SAFETY SUBMISSION FOR THE ZERO ENERGY PHASE OF OPERATION OF THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Dickson, A. N. (ed.) (Atomic Energy Establishment, Winfrith (England)). Sep 1964. 115p. Dep. CFSTI.

The operations considered in the safety submission are concerned with loading a complete charge of live fuel elements and with conducting low power experiments to determine: total reactivity invested; effectiveness of control rods; and temperature coefficient of reactivity. Detailed safety assessments are given for the primary circuit, fuel handling, reactivity control, emergency shutdown, etc. The safety system monitors all important physical quantities and provides adequate protection for all credible reactivity incidents. Appendices are included on the administrative control of the safety system by-pass panel, nucleonic instrumentation, heat production by oxidation of graphite after rupture of the primary circuit, reactor shielding during low power operation, experimental equipment, and standing orders. (auth)

41037 (DP-Report-323) DESIGN SAFETY REPORT OF THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Dickson, A. N. (ed.). (Atomic Energy Establishment, Winfrith (England)). May 1965. 380p. Dep. CFSTI.

The safety of the Dragon Reactor System from the design aspect and a hazards analysis are presented. (auth)

41038 (NP-9384) PRELIMINARY SAFETY EVALUATION OF THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Dickson, A. N.; Schmidt, H. (Atomic Energy Establishment, Winfrith (England)). Apr 1960. 115p. (DP-Report-4). Dep. CFSTI.

A brief description of the Dragon Project Reactor Experiment is given, including the basic principles which affect safety considerations. Emphasis is put on outlining the general requirements from the safety point of view and describing methods of meeting these requirements. (auth)

Research and Test Reactors

Refer also to abstracts 39207, 39687, 40892, 41002, 41010, and 41011.

41039 (DOCKET-50231-51) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Technical Specifications, Modification of Change No. 2. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 30 Jul 1970. 3p. Dep. CFSTI.

Revised qualifications for operation personnel are presented. (D.C.C.)

41040 (EUR-4415) METHOD FOR DETERMINATION OF CONVERTIBLE NUCLEAR HEATING DATA. Kroeckel, H. (European Atomic Energy Community, Petten (Netherlands). Joint Nuclear Research Center). 10 Oct 1969. 44p. Dep. CFSTI (U. S. Sales Only). EUR FF 6.65.

The nuclear heat generation process is analyzed and presented in well-known form as a function of the neutron and gamma energy distributions. The energy distributions are approximated by expressions containing three unknown parameters which appear, after insertion, as three unknown linear constants in the heating equation. By setting up this equation for three different materials, a system of three linear equations is obtained, the coefficients of which are computable functions. The solution of this system is presented in terms of experimentally determined nuclear heating values of the three materials. The known solution can be used for calculation of nuclear heating data for any desired sample size and material by the same linear expression. Numerical coefficients of this expression are given for materials C, Be, Mo and Fe as function of sample size. A test rig, CADO-17 for measurements in the High Flux Reactor (HFR) at Petten is described; the chosen sample materials are C, Be and Mo. 8 references. (auth)

41041 (FMRB-8) REPORT OF EXPERIENCES ON THE OPERATION OF THE BRAUNSCHWEIG RESEARCH AND MEASUREMENT REACTOR FOR THE PERIOD OCTOBER 1967–OCTOBER 1968. Heintz, W.; Siegel, V. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Nov 1968. 54p. (In German). Dep. CFSTI (U. S. Sales Only).

The FMRB reactor went critical in October 1967. It was designed for a maximum power of 1 MW. Attempts to reach that power revealed insufficiency of the primary cooling system; therefore, maximum power of the reactor was restricted to 200 kW. Experiences gained throughout the year 1967 to 1968 were analyzed as to performance of: primary cooling system, control rod shutdown, reactor instrumentation, reactor start-up, continuous operation, modification of core configuration, personnel dosimetry, monitoring of environment, and emergency procedures. (16 references) (H.B.G.)

41042 (FMRB-23) SEVERAL REACTOR PHYSICAL PRINCIPLES FOR THE START UP OF THE RESEARCH AND MEASUREMENT REACTOR WITH TWO COUPLED CORES. Roethemeyer, H. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). May 1968. 21p. (In German). Dep. CFSTI (U. S. Sales Only).

The FMRB reactor consists of two core arrangements with rectangular cross section. Through a heavy-water tank, the two cores are coupled weakly as to neutron flux. For the double-core system, the Inhour equation is developed and discussed. Total reactivity in relationship to parameters of each core allows inferences about the degree of coupling and reactivity jumps in the coupled system as compared to each single core. (11 references) (H.B.G.)

41043 (FMRB-24) REPORT OF EXPERIENCE ON THE CONTINUOUS OPERATION AT 100 kW AND 200 kW OF THE RESEARCH AND MEASUREMENT REACTOR. Eggelsmann, H.; Heintz, W.; Kriks, H.-J.; Rasp, W.; Siegel, V. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Mar 1968. 16p. (In German). Dep. CFSTI (U. S. Sales Only).

In connection with the start-up program of the FMRB reactor, several factors were measured during continuous operation between 100 kW and 200 kW. For natural convection or forced circulation cooling, the reactor was studied as to the radioactivity and temperature of the swimming pool water and the conductivity and acidity of both primary and secondary water circuits. Type and activity of isotopes in the swimming pool are listed; no fission products were detected. The acidity of the pool water at all depths corresponded to a pH of 5. (H.B.G.)

41044 (FMRB-25) REPORT ON CARRYING OUT THE STARTING PROGRAM ON THE RESEARCH AND MEASUREMENT REACTOR. Heintz, W.; Roethemeyer, H.; Siegel, V. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Feb 1968. 30p. (In German). Dep. CFSTI (U. S. Sales Only).

The start-up program of the FMRB reactor is described for a 5 × 5 core arrangement and a power output between 0 and 200 kW. Results are presented on criticality experiments, reactivity measurements, instrumentation, personnel dosimetry, radioactivity of the pool water, and contamination of equipment. (H.B.G.)

41045 (TRG-Report-1911, pp 145-59) PRESENTATION OF RAPSODIE–FORTISSIMO. Ginier, R.; Chaumont, J. M.; Clottes, G.; Denielou, G.; Gollion, H. G. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires).

Limitations of Rapsodie for fuel element irradiation testing, particularly in relation to integrated fluxes, led to the Fortissimo project. The aim is to obtain in Rapsodie the higher possible flux and greater available reactivity. Design philosophy is explained in terms of flux increase, core power and coolant flow rate, and the use of a Ni reflector. Problems encountered were mainly

associated with increase in flow rate: they included cavitation, vibration and free level control. These are examined in relation to fuel elements, heat-exchangers and pumps. Fuel handling and storage is discussed. The characteristics and schedule of Rapsodie–Fortissimo are presented. (UK)

41046 (TRG-Report-1911, pp 184-204) EXPERIENCE GAINED WITH THE 200 kW INTEGRATED IN-PILE SODIUM LOOP IN THE BR2 REACTOR. Soenen, M. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)).

Improvements and experience on in-pile sections of the loop, which is used for irradiation of fuel pins under nuclear screened conditions, are described. Improvements in loop performance include the use of parallel sets of fuel pins in a given pitch in the test finger, and the use of additional thermocouples. Descriptions are given of the operation of a loop in which fuel failure was detected after 2 days, and also of the dismantling of this loop. There are details of a core configuration in a nuclear mock-up of BR2 with a loop in a peripheral channel and one in the central channel. Burnup calculations are presented on a neutron screen incorporporated in the test finger of the loop. (UK)

41047 (TRG-Report-1911, pp 205-19) IN-PILE SODIUM LOOP-500 kW CONCEPTIONAL DESIGN. Vanmassenhove, G. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)).

The loop is designed for irradiation of fuel bundles under epithermal and fast flux conditions, the thermal neutrons being eliminated by a Cd screen. Main parameters are presented and the loop circuitry is described. Instrumentation is provided in the integrated Na circuit to evaluate the heat input by thermal balance; the whole Na equipment is one unit and is enclosed in one containment tube. The intermediate CO_2 circuit is mounted directly above the Na circuit, forming an integral part of the loop. The final heat disposal circuit uses the reactor water and the pool water as heat sinks. Fuel failures are detected by continuous analysis of the Na cover gas. Loop instrumentation and charge-discharge operations are described. Safety aspects are considered. (UK)

41048 (TRG-Report-1911, pp 253-65) FAST REACTOR CARBIDE FUEL ELEMENTS. Golovnin, I. S.; Menshikova, T. S.; Reshetnikov, F. G.; Bibilashvili, Yu. K.; Rodin, V. M.; Rogozkin, B. D.; Mukhin, V. S. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii).

The fuel element of the BR-5 experimental fast reactor and the method of production of the carbide fuel are described. Out-of-pile compatibility of UC fuel with stainless steel cans was investigated. In-pile investigations included compatibility tests in the SM-2 reactor. It was established that the compatibility of U-4.8 wt % C with 16 Cr-15 Ni-Mo-Nb through a Na sub-layer, is satisfactory. Compatibility of the can with hyperstoichiometric carbides may be improved by alloying the fuel with Fe or Cr, or by coating the pellets with Cr. There is a description of the fuel element for experimental assemblies in BOR-60. 18 references. (UK)

41049 (TRG-Report-1911, pp 287-309) RIGS FOR IRRADIATION IN BR.2 OF FUEL FOR FAST REACTORS. PART (I). BR.2 IRRADIATION OF FUEL PINS IN LIQUID METAL RIGS. von der Hardt, P. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)).

Development and performance of several liquid metal filled irradiation devices containing fuel pins are described. One such rig is for the irradiation of carbide fuels in thermal flux conditions at canning temperatures of 600 to 700°C and linear power 1000 to 1500W/cm. An instrumented and regulated capsule was designed for fuel pins 6 mm OD and cladding temperatures up to 700°C, to be irradiated up to 700 W/cm in NaK surrounded by an incorporated Cd screen. Basic types of capsules contain thermocouples for measuring cladding temperature. Developments in progress include a power cycling rig and devices for measurement and control of pressure inside and outside the fuel pins. 7 references. (UK)

41050 (TRG-Report-1911, pp 310-37) EXPERIMENTAL DEVICES FOR FAST IRRADIATIONS. Bel, A. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires); Leclere, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires); Millies, P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires); Rousseau, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

Irradiation devices for fuels and structural materials in thermal reactors Osiris and Siloe, and in the fast reactor Rapsodie, are described. Fuel samples may be irradiated in thermal reactors in static Na under varying conditions of specific power, temperature and burnup. Loop or thermosyphon devices may be used for experiments on failed or vented fuels. Irradiation devices for structural materials aim to provide specific temperature conditions using γ heating or furnaces, such as the Chouca furnaces used in Osiris to permit continuous in-pile creep measurements of cladding. Early experiments in Rapsodie were principally technological tests for fuel pins and assemblies. Future experiments may be more fundamental, and instrumented devices are probable. (UK)

41051 (TRG-Report-1911, pp 338-45) RIGS FOR IRRADIATION IN BR.2 OF FUEL FOR FAST REACTORS THERMAL NEUTRON FUEL IRRADIATION FACILITY WITH CONTINUOUS HEAT FLUX MEASUREMENTS. Lhost, A. (Societe Belge pour l'Industrie Nucleaire, Brussels).

An instrumented and regulated type of rig is described which was developed for irradiation of fuel pins in a thermal flux, with continuous measurement of the linear power dissipated by the fuel, and with temperature control. Depending upon the thickness of the NaK gap the fuel cladding could be brought to 500 to 600°C for a linear power of 600 to 700 W/cm. Five such rigs are under irradiation. Burnups of 10,000 to 35,000 MWd/T have been reached. 4 references. (UK)

41052 (TRG-Report-1911, pp 503-18) DESIGN FEATURES AND TESTING CAPABILITIES OF THE FAST FLUX TEST FACILITY. Arneson, S. O. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The primary objectives of the FFTF are stated. Details are given of overall plant layout, reactor core, irradiation testing facilities, experimental handling, and examination facilities. Notable design features include the provision of multiple independent closed loops for testing fuel pins and assemblies, and instrumentation of all driver fuel positions. A computer based data handling system is provided. (UK)

41053 (TRG-Report-1911, pp 519-30) FAST FLUX TEST FACILITIES PLANNED FOR JAPAN EXPERIMENTAL FAST BREEDER REACTOR. Uematsu, Kunihiko; Kashihara, Hidechiyo; Kubota, Tadashi; Ohno, Tadao (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)).

The reactor will provide fast flux irradiation space for fuel and materials development, and is designed to give ample fuel height and high power density. A special feature is that of fuel assemblies which may be considered as irradiation rigs. Features of several of these are discussed. In some, part of the fuel pin bundle may be remotely disassembled and re-assembled from the fuel assembly in a hot cell. Details of the capability of the $\alpha-\gamma$ facility for testing of irradiated PuO_2-UO_2 pins are tabulated. The Fuel Monitoring Facility, which is described, is a high activity $\alpha-\gamma$ post-irradiation examination cell. The Materials Monitoring Facility is a semi-$\alpha-\gamma$ hot cell for obtaining irradiation creep and fatigue data. (UK)

41054 (TRG-Report-1911, pp 564-95) P.E.C.: FAST REACTOR FUEL IRRADIATION FACILITY. Aiello, P.; Fogagnolo, G.; Pierantoni, F.; Zona, R. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)).

The reactor is a 140 MW(+) Na-cooled facility, provided with a driver core and a central test zone. The test zone comprises three closed circuit loops which can have operating conditions independent from the driven core, the loops being so designed that high performance vented and non-vented fuel can be tested with a conservatively rated driver core initiating the flux. Details are given of the core, test zone, pressure vessels and shields, charging machine, control rods, fuel transfer, fuel handling, coolant circuits, control and instrumentation. Calculations are presented on the performance of fuel in the loop. (UK)

41055 USE OF A SMALL COMPUTER AS A COMMUNICATIONS CONTROLLER OF MULTI-USER ON-LINE SYSTEMS. Felberbaum, Joan; Dimmler, D. Gerd (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 419-22(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

A programmed communications controller (PCC) was designed using a small digital computer. The PCC is connected to a multi-user on-line system which controls nine experiments at the Brookhaven High Flux Beam Reactor. The purpose of the PCC is to process and switch all messages between sixteen teletypewriter terminals and the time-sharing system. The PCC serves "local" terminals at each experiment and "remote" terminals at distances up to one mile from the reactor. The PCC also controls message transfers between local and remote terminals. Arguments are given why a digital computer was chosen rather than a hardwired device. (auth)

41056 SAFETY SYSTEMS DESIGN AND CRITERIA EVOLVE TOGETHER: LESSONS FROM THE HFIR. Rubel, P. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 581-5(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The development of system design guidelines for reactor safety instrumentation and controls consists largely of evaluating modern practice. Difficulties in reducing the HFIR protection system practice to definitive criteria are analyzed. Arguments are advanced for increasing the emphasis on informal guidance documents to supplement concise criteria. 4 references. (auth)

Rocket and Space Reactors

41057 HIGH SPEED DATA ACQUISITION SYSTEM FOR REACTOR TRANSIENT EXPERIMENTS. Thiele, A. W. (Atomics International, Canoga Park, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 532-3(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

Temperature limited reactor transients were conducted to measure the prompt temperature coefficient of a SNAP reactor. In order to calculate the temperature coefficient it is necessary to have data on the power and temperature as a function of time during the transient. The transient power rises with periods as short as 1.5 milliseconds and reaches a level of several hundred megawatts. The entire transient is completed in times as short as 300 milliseconds. The data from the transient must be presented in digital form for processing by a computer code. The signal sources for this system include radiation detectors, temperature detectors, and timing signals. The reactor flux level is measured by scintillation detectors using plastic scintillators. Photomultiplier tubes are used in detectors covering power levels up to about 100 kW and photodiodes are used from 100 kW to 1000 MW. The currents from these tubes are amplified with sensitivities adjusted to give overlapping coverage over the full power range. Energy probes, a thermocouple affixed to a small piece of thermally insulated fuel material, are used to sense temperature rise and the related quantity, energy release. The signal acquisition and recording system is described. (auth)

Process Heat and Desalination Reactors

41058 (EUR-4420) STUDY ON THE USE OF ENERGY SUPPLIED BY HIGH-TEMPERATURE REACTORS FOR THE REDUCTION OF IRON ORE. Schenck, H.; Wenzel, W. (Technische Hochschule, Aachen (West Germany)). 1970. Contract 042-68-3-ECIC. 198p. (In German). Dep. CFSTI (U. S. Sales Only). EUR DM 21,30.

The application of nuclear-produced energy to the iron and steel industry was studied. Two processes for the direct reduction of iron ores were decided on for such an application. In the first the reduction is carried out with a reducing gas obtained from methane (at a temperature of 800°C), whereas in the second a gas obtained from fossil fuels is used (at a temperature of 1,150°C). A helium-cooled high temperature reactor provides the heat necessary for the production of the reducing gas and the electricity used for smelting the iron sponge in an electric furnace and for processing the raw steel. A production capacity of 3.6 million ton/yr is planned for the plant. A technical description is given of the nuclear reactor, the heat exchangers and the reduction processes. Finally, the cost of producing molten steel by the processes described was estimated and compared with that of molten steel produced by traditional methods (blast furnaces/LD converter and iron sponge in a rotary kiln/electric furnace). (auth) (EURATOM)

Marine and Portable Power Reactors

41059 (DOCKET-50238-63) N. S. SAVANNAH. Operating License NS-1. Technical Specifications Change No. 24. (First Atomic Ship Transport, Inc., New York). 24 Jul 1970. 3p. Dep. CFSTI.

Technical specifications relating to shutdown condition for the reactor are presented. Personnel requirements are described. (D.C.C.)

Reactor Theory

Kinetics

Refer also to abstracts 40908, 40910, 40914, 40918, 40920, 40937, 40938, and 40939.

41060 (DP-Report-155) REPRESENTATION OF THE NEUTRON SPECTRUM BY AN ANALYTICAL EXPRESSION AND APPLICATION. Project DRAGON. Bruneder, H. (Atomic Energy Establishment, Winfrith (England)). Mar 1963. 39p. (CONF-630511-8). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

Because of the spectrum changes during the burn-up in HTGR-systems, it is necessary to modify the reaction rates due to these changes. To avoid the run of a criticality multi-group diffusion routine, the attempt was made to represent, for survey calculations of an accuracy of about 2% in the reaction rate, the spectrum by a relative simple analytical expression. This attempt, the error, and some indication for the next step to represent the cross sections by few parameters are discussed. (auth)

41061 (RT/FI-(69)43) THE CLETA CODE. Bitelli, G.; Cecchini, G.; Dal Bono, I.; Leproni, V.; Salvatores, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). [1966]. 21p. Dep. CFSTI (U. S. Sales Only).

The CLETA code calculates cross-section libraries for reactor lattices taking into account the fine flux structure and the heterogeneity effects on self-shielding factors. (auth)

41062 (RT/FIMA-(69)3) ANALYSIS OF THE INTEGRAL AND EXACT RESULTS OF SOME STATIONARY MULTIGROUP DIFFUSION CODES. Daneri, A.; Melandri, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 14 Apr 1969. 41p. (In Italian). (PRV-r-(68)29). Dep. CFSTI (U. S. Sales Only).

The results of some bidimensional diffusion nuclear codes are compared. The differences between integral and punctual quantities are taken into account. The differences are explained on the basis of the mathematical methods adopted in the solution of elliptic equations in diffusion theory. 14 references. (auth)

41063 (TRG-Report-1911, pp 411-29) ANALYTICAL APPROXIMATIONS IN FAST NEUTRON SPECTROMETRY. Purica, I.; Grancea, I.; Cuculeanu, V. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica).

Indirect measurements of fast neutron spectra may be determined by the use of threshold detectors. Mathematical methods suitable for interpreting the activities of a number of threshold detectors are considered. Analytical methods give correct information concerning fast neutron spectrum deformation. The method of orthogonal functions is not acceptable. 10 references. (auth)

41064 CALCULATION OF PROMPT TEMPERATURE COEFFICIENTS IN A ZrH-MODERATED LATTICE. Lahner, K. (INTERATOM, Bensberg, Ger.). Atomwirt., Atomtech.; 15: 340-1 (Jul 1970). (In German).

To calculate the prompt temperature coefficient for a ZrH/H_2O moderated lattice, consideration of temperature distribution along the fuel rod is essential. Calculations are based on a uranium–ZrH fuel mixture containing 8.5% uranium by weight which is 20% enriched. Temperature distribution along the rod is represented by three step-functions. The reason for the effect of temperature distribution resides in the cool water region adjacent to the fuel rod which strongly disturbs the spectrum. (H.B.G.)

41065 NODAL APPROACH TO SOLVE FEW REGION NEUTRON DIFFUSION PROBLEMS. Rinaldini, C. (CCR-EURATOM, Ispra, Italy). Energ. Nucl. (Milan); 17: 429-35(Jul 1970).

A new approach is proposed for treating neutron diffusion problems by nodal method. The one dimension, analytical solution of the diffusion equations with an appropriate choice of the boundary conditions is employed in order to get the coupling between adjacent regions. Interesting applications to reactor kinetics and fuel evolution problems are possible with a sizable computer time saving, if compared to finite differences methods, and with much higher accuracy, if compared to alternative nodal methods. (8 references) (auth)

41066 OPTIMAL DIGITAL COMPUTER CONTROL OF NUCLEAR REACTORS. Lipinski, Walter C. (Argonne National Lab., Ill.); Vacroux, Andre G. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 1, 510-16(Feb 1970).

From 16th Nuclear Science Symposium, San Francisco, Calif. See CONF-691017-(Pt.1).

The use of a digital computer to achieve closed loop optimal

control of a nuclear reactor is presented. A performance index is defined, and dynamic programming is applied to derive an optimal stationary feedback control law. The control law requires that all state variables be available, therefore nonlinear estimation is used to generate the nonmeasurable system state variables. 3 references. (auth)

Experimental Applications

Refer also to abstract 40907.

41067 (RT/FI–(69)54) ANALYSIS OF A SET OF SPECTRAL INDEX MEASUREMENTS IN MULTIPLYING LATTICES BY APPLYING A CORRELATION METHOD. Pistella, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 15 Dec 1969. 32p. Dep. CFSTI (U. S. Sales Only).

A correlation method, devised to evaluate an unknown reaction rate by means of measured activation rates, is applied to analyze a set of spectral index measurements performed in different uranium fueled lattices. Moreover a procedure is suggested to evaluate quantitatively to what extent experimental accuracy in spectral index measurements affects the determination of the reaction rate sought. In addition, the cross section set prepared for the spectral detectors is tested. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 39111, 39122, 39123, 39206, 39272, 39393, 39615, 39639, 39686, 39690, 39694, and 39724.

41068 METHOD FOR MEASURING THE THERMAL NEUTRON FLUX DISTRIBUTION IN AND AT A CENTRAL FUEL ROD AND CENTRAL POISON RODS IN A FUEL ELEMENT CLUSTER. Krull, W.; Wiegandt, M. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH., Geesthacht, Ger.). Atomkernenergie; 16: 89–90(1970). (In German).

The effect of a central poison rod on thermal neutron distribution throughout a fuel element cluster was studied. Poison rods consisted of various materials containing boron. To measure the thermal neutron flux, thin copper wires were extended throughout the fuel element cluster, and their radioactivity measured with a wire scanner. 6 references. (H.B.G.)

41069 COMPARISON OF MEASURED AND CALCULATED DISADVANTAGE FACTORS IN SPHERICAL FUEL ELEMENTS. Bonka, H. (Lehrstuhl fuer Reaktortechnik, Aachen); Krings, F. Atomwirt., Atomtech.; 15: 342-3(Jul 1970). (In German).

In the thermal column of the Juelich test reactor, FRJ I, two types of spheres were irradiated. The first had a core of 93% enriched uranium and ^{232}Th. The other had a core of natural uranium and ^{232}Th. The spheres were coated by graphite and contained a thin aluminum tube drilled through one diameter. In the tube, small pieces of Dy were placed, and from the induced activity of ^{164}Dy, neutron distribution was determined. Neutron distribution was also calculated with a computer program. Agreement between experimental and theoretical values was satisfactory. 9 references. (H.B.G.)

41070 HIGH-BURNUP BEHAVIOR OF UO_2–SiO_2 VITROCERAMICS. Lungu, S.; Beleuta, I. L. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 35–40(1970).

Preliminary studies on the effect of reactor irradiations up to 10,000 MWd/t on specific volume and xenon release from UO_2–SiO_2 vitroceramics are reported. The revealed effects are: (1) a contraction quasi-linearly increasing with irradiation at 300 and 500°C but negligible at 700°C for previously thermally treated samples; (2) an important swelling at above 800°C; and (3) a very good retention of the fission gas, especially at high temperatures (~1100°C). 6 references. (auth)

GENERAL

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Thesis.

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From 67th National Meeting of the American Institute of Chemical Engineers, Atlanta, Ga.

41081 (BNWL-tr-53) EFFECT OF TEMPERATURE ON THE SUSCEPTIBILITY TO STRESS-CORROSION CRACKING OF STAINLESS STEELS. Kishima, Shigeru. Translated for Battelle-Northwest, Richland, Wash., from Boshogu Gijutsu; 17: 381-8(1968). 21p. Dep. CFSTI.

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A brief review is given of previous work on development of leaf primordia in the ferns, Dryopteris aristata and Osmunda cinnamomea. Results to date indicate that in Osmunda cinnamomea primordia set off at the flanks of the shoot apical meristem proceed through at least three distinct developmental phases by which time they are fully, and irreversibly, determined as leaves, though under normal conditions this is never manifested; there is a very real "active principle" which will depress developmental phase II, leaf + bud, and thus be active in determining these primordia in developmental phase III; there appear to be two sources or sites of production of the "active principle"— the rhizome shoot apical meristem, and leaf primordia, but principally oldest leaf primordia of Set I; that activity of the "active principle" appears to be temperature independent; that GA_3 appears to mimic the actions of "active principle" in that it, too, is involved in, or is able to suppress expression of the adventitious, adaxial bud; the irreversible determination of primordia occurs while a primordium is part of the Set I primordial group; that four distinct pigment systems are demonstrable in developing leaf primordia, and which play significant roles in growth and development of oldest Set I, youngest Set II primordia. For example: phytochrome— chlorophyll and carotenoid synthesis, P_{730}— chlorophyll and carotenoid synthesis, and inhibition of primordial elongation, P_{730}— stimulates primordial elongation, P_{660}— involved in fresh weight increase, and xylem differentiation; only youngest, Pj primordia, can express in developmental phases I, II, and III, and that primordia in developmental phase I cannot be considered to be in the determined state; that leaf primordia appear to express preferentially in developmental phase II only over the winter or dormant period of the annual cycle; that the "active principle" appears to have a molecular weight of no greater than 12,000 based on dialysis experiments; high starch accumulation may be associated with the capacity of primordia to express preferentially in developmental phase II. (auth)

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Thesis. Submitted by C. E. Baker to Univ. of Tennessee, Knoxville.

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The subject article is analyzed primarily from the standpoint of criticism of the ORNL agro-industrial study project. Several areas of criticism, e.g. marketing and demonstration of large-scale technology are in agreement with some of the recommendations given in ORNL-4290. In general, a point-by-point discussion of the subject article is given. Some recently developed data giving a further analysis of the 1967 study (ORNL-4290) are included as an appendix on future prospects. (auth)

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41137 (SC-RR-70-332) TEST FOR DETERMINING THE STATE-OF-CHARGE OF ZINC–MERCURIC OXIDE PRIMARY BATTERIES. Levy, Samuel C.; Reinhardt, Frederick W. (Sandia Labs., Albuquerque, N. Mex.). Jun 1970. 25p. Dep. CFSTI.

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41144 (STI/PUB-254) HANDLING OF NUCLEAR INFORMATION. Proceedings Series. Proceedings of the Symposium Held in Vienna, 16-20 February 1970. (International Atomic Energy Agency, Vienna (Austria)). Jul 1970. 687p. (In several languages). (CONF-700206). IAEA $18.00.
Fifty-seven papers presented at the conference are included under the following headings: national and institutional information centers; specialized information centers; manual, mechanized, and computerized information services; primary publications; secondary publications; nuclear libraries and services; organization and coordination of scientific conferences; indexing methods and systems; and world-wide cooperation in scientific information. (M.C.G.)

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